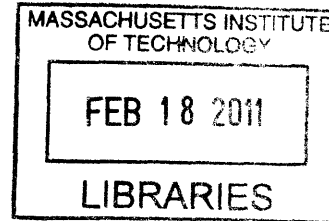


# Last Resorts

## A Tour Guide to Territorial Protection for the Republic of the Maldives

by Buck Sleeper



**ARCHIVES**

B.A. History of Art and Architecture  
Middlebury College, 2005

Submitted to the Department of Architecture, February 2011  
in partial fulfillment of the requirements for the degree of  
Master of Architecture at the Massachusetts Institute of Technology

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Signature of Author \_\_\_\_\_

A handwritten signature in black ink, appearing to be "Buck Sleeper", written over a horizontal line.

Buck Sleeper  
Department of Architecture  
January 14, 2011

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# Last Resorts

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### **Abstract**

A two meter rise in sea levels projected by the end of this century threatens the sovereignty of the Maldivian nation state. While flight from the Maldives to establish a new homeland elsewhere has been proposed, the culture and economy of this country is inextricably entrenched in its geophysical environment. Although the Maldives is known for super luxury resorts, the nation's government is poorly positioned to defend a population of 400,000 people spread across 1200 islands. This thesis proposes a strategy by which the international resort operator, an autonomous and independently funded entity, can be mobilized as an agent of coastal defense.

Also investigated are issues of artificial reef ecology, defensive coastal infrastructures, and prefabricated composite construction and modularity.

Thesis Supervisor: Ana Miljački  
Title: Assistant Professor of Architecture

To Ana, Mark, and Nasser, thank you for your incredible guidance throughout this adventure.

And to Letizia, for everything else.

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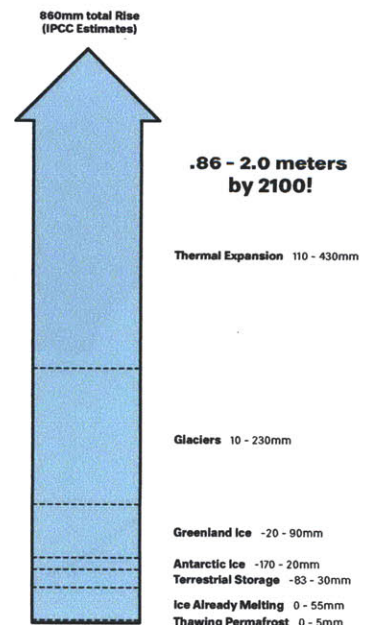
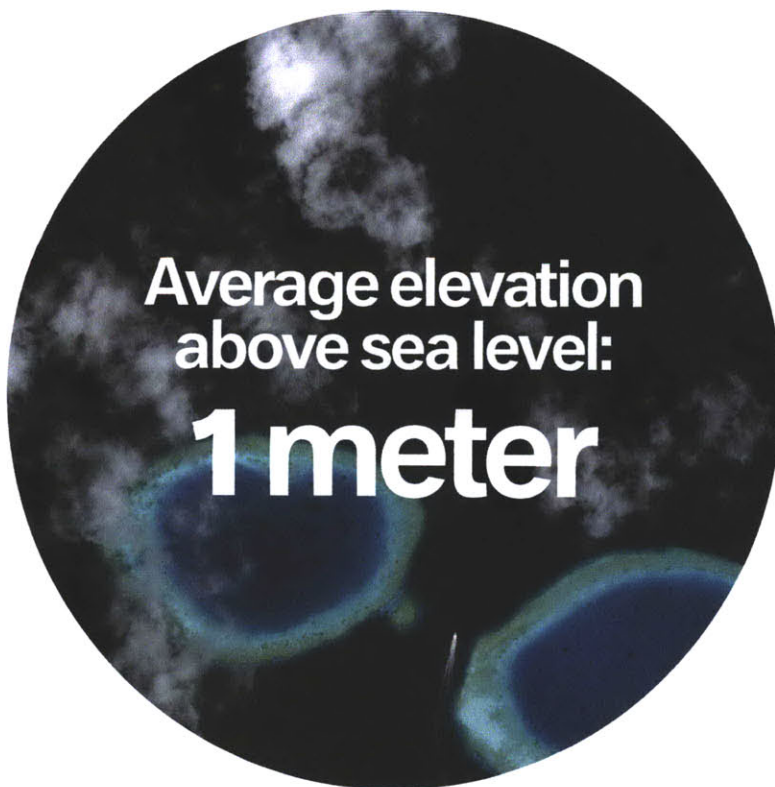


# Last Resorts!

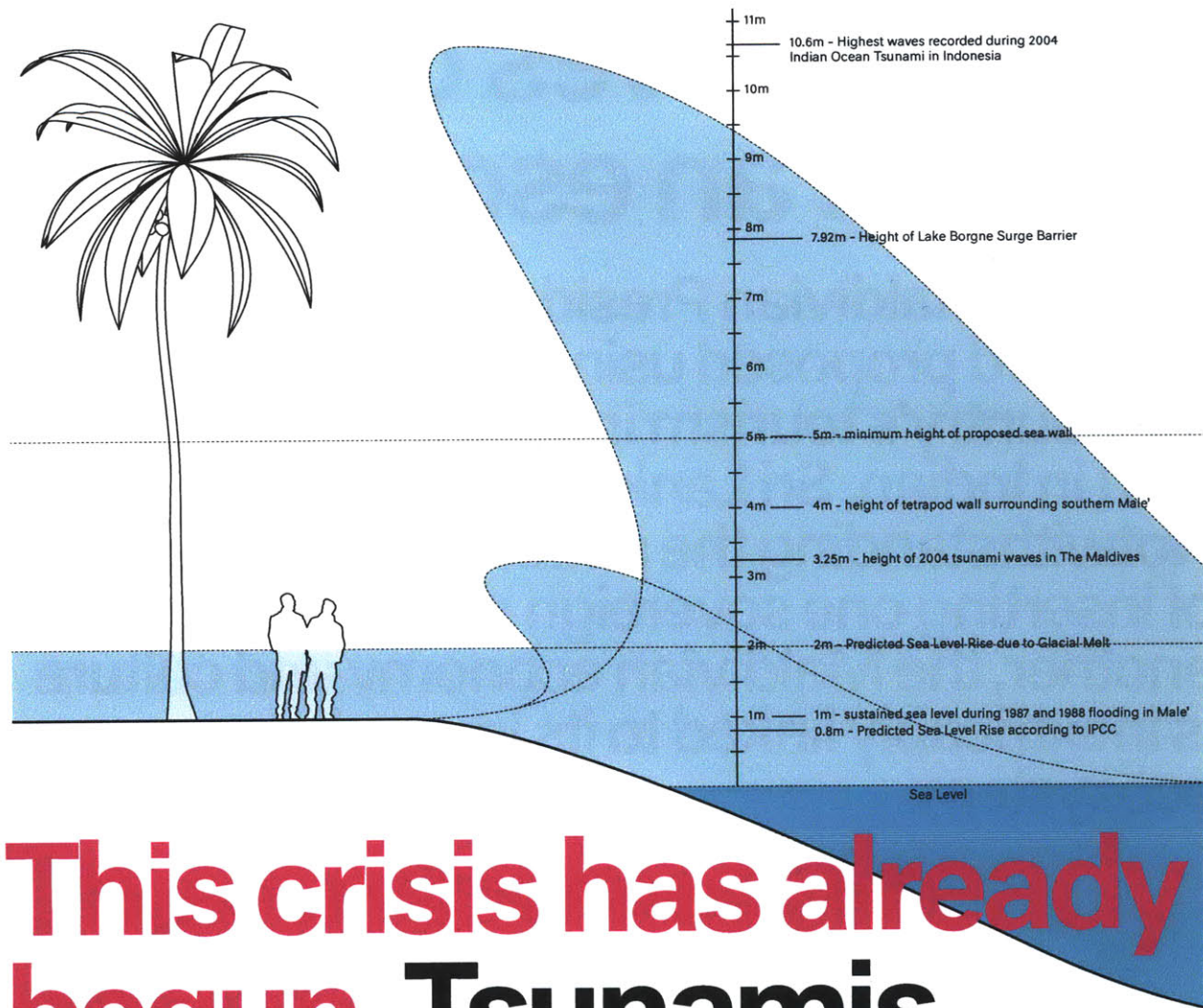
**A Tour Guide to Territorial Protection  
for the Republic of the Maldives**



# By 2100, rising sea levels will consume the Maldives in its entirety. Without land, the country cannot survive.



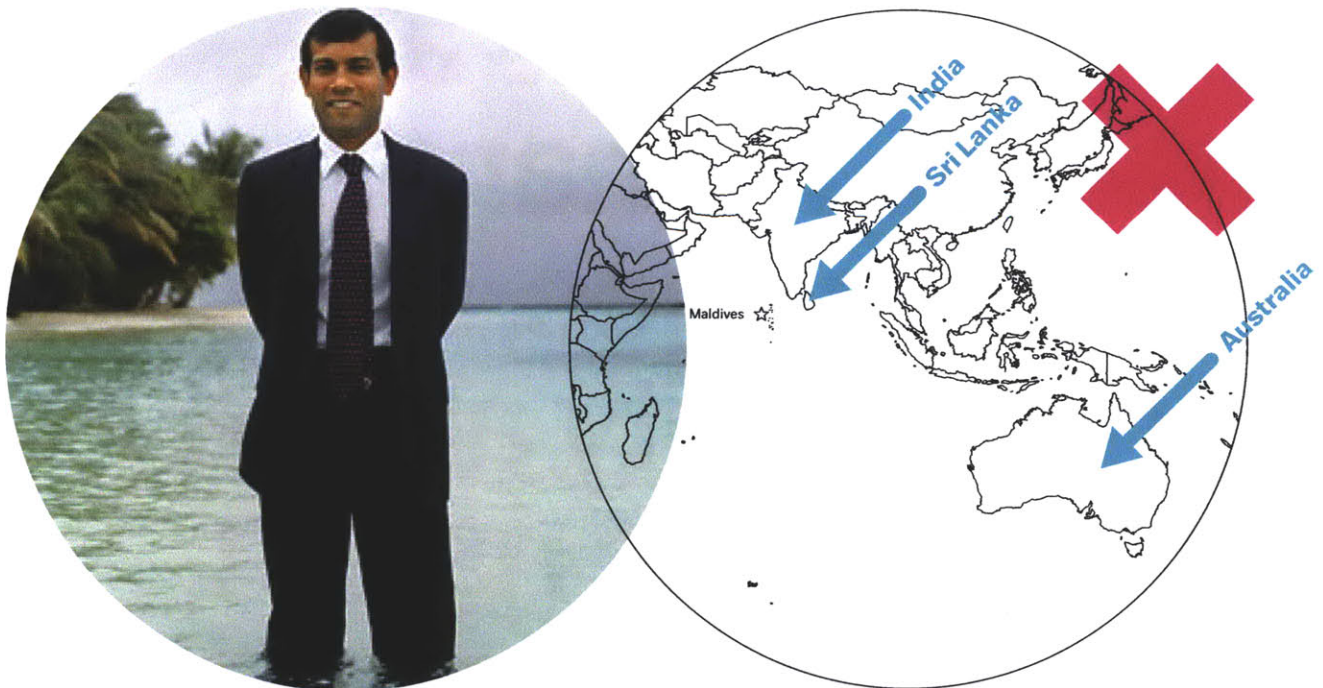




**This crisis has already begun. Tsunamis, storm surges, and land scarcity already threaten the nation. The Maldives needs immediate action!**

# The Maldives cannot survive an escape!

In 2008, Maldivian President Mohamed Nasheed proposed using income from the country's tourism industry to purchase land in Indian, Sri Lanka, and Australia. Notwithstanding the political difficulties of inserting one sovereign nation into another, the Maldivian economy and culture is inextricably linked to its immediate ecosystem.



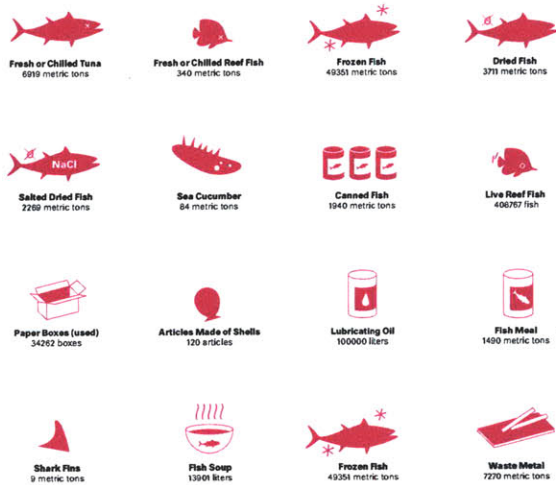
**"We can do nothing to stop climate change on our own, and so we have to buy land elsewhere."**

Mohamed Nasheed, President of the Maldives  
The New York Times, May 8, 2009

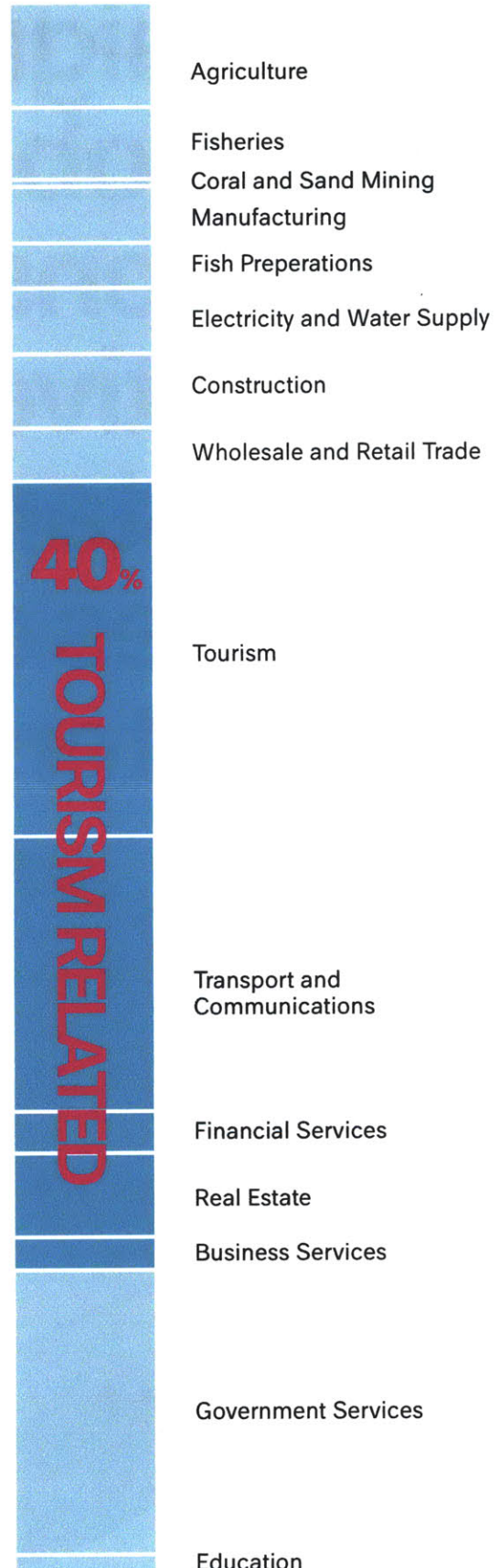


# The Maldivian economy is mostly tourism! Maldivian industry is mostly fish!

## Imports:



## Exports:



# Campaigns to curb global carbon emissions are ineffective; eco-grandstanding impedes development and deters tourism!

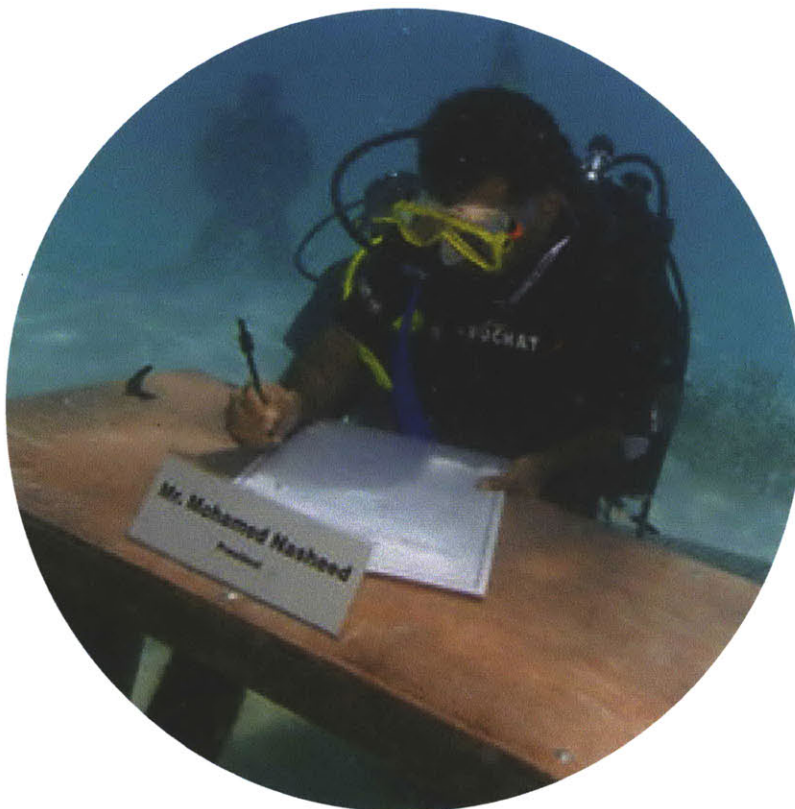
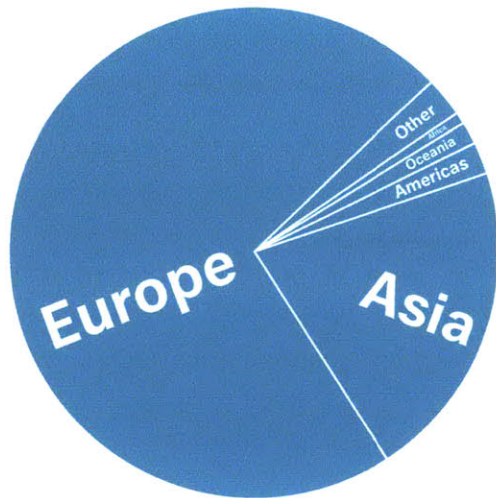
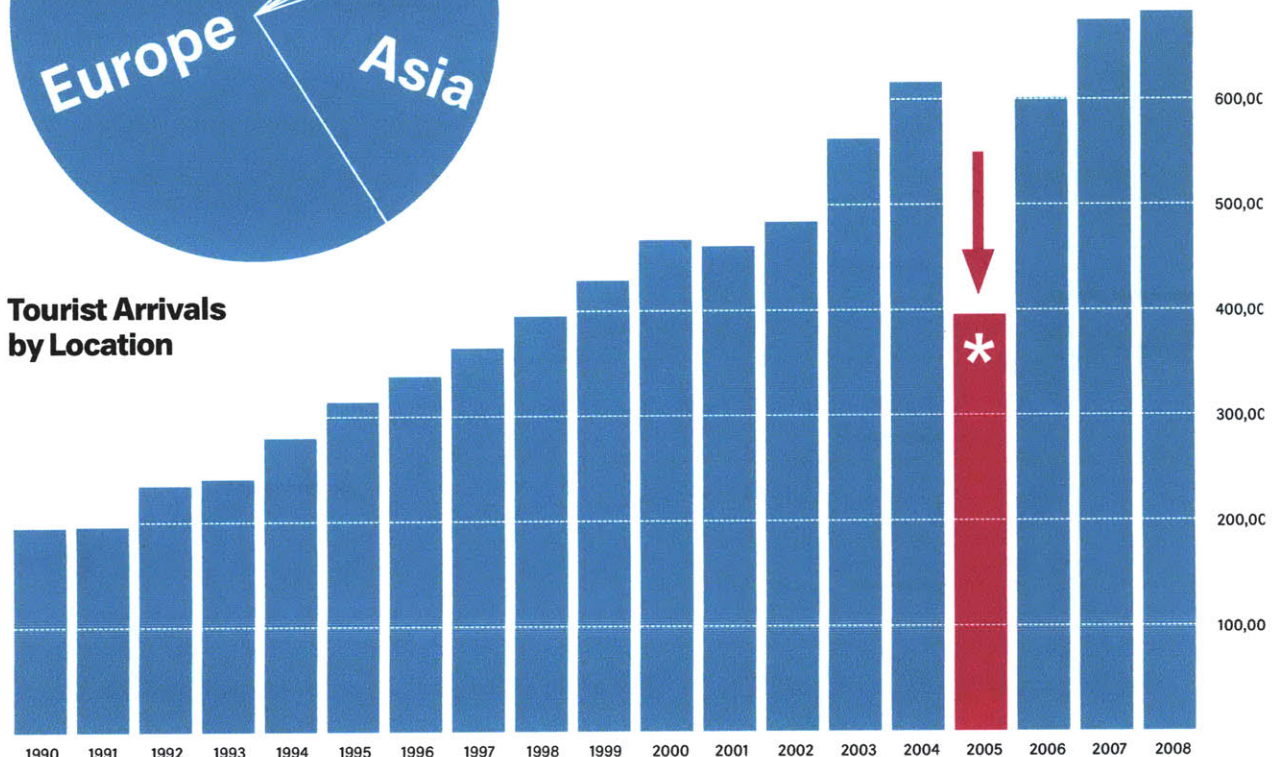


photo: mohamed seneen

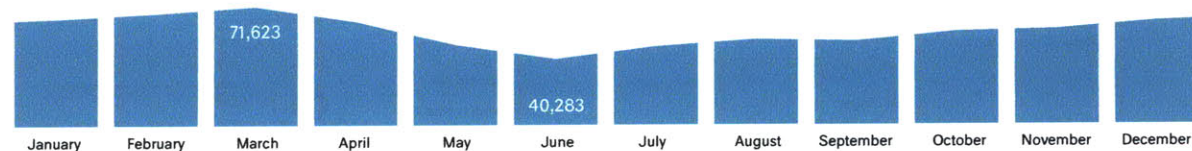


**Tourist Arrivals by Location**



**Tourist Arrivals by Year**

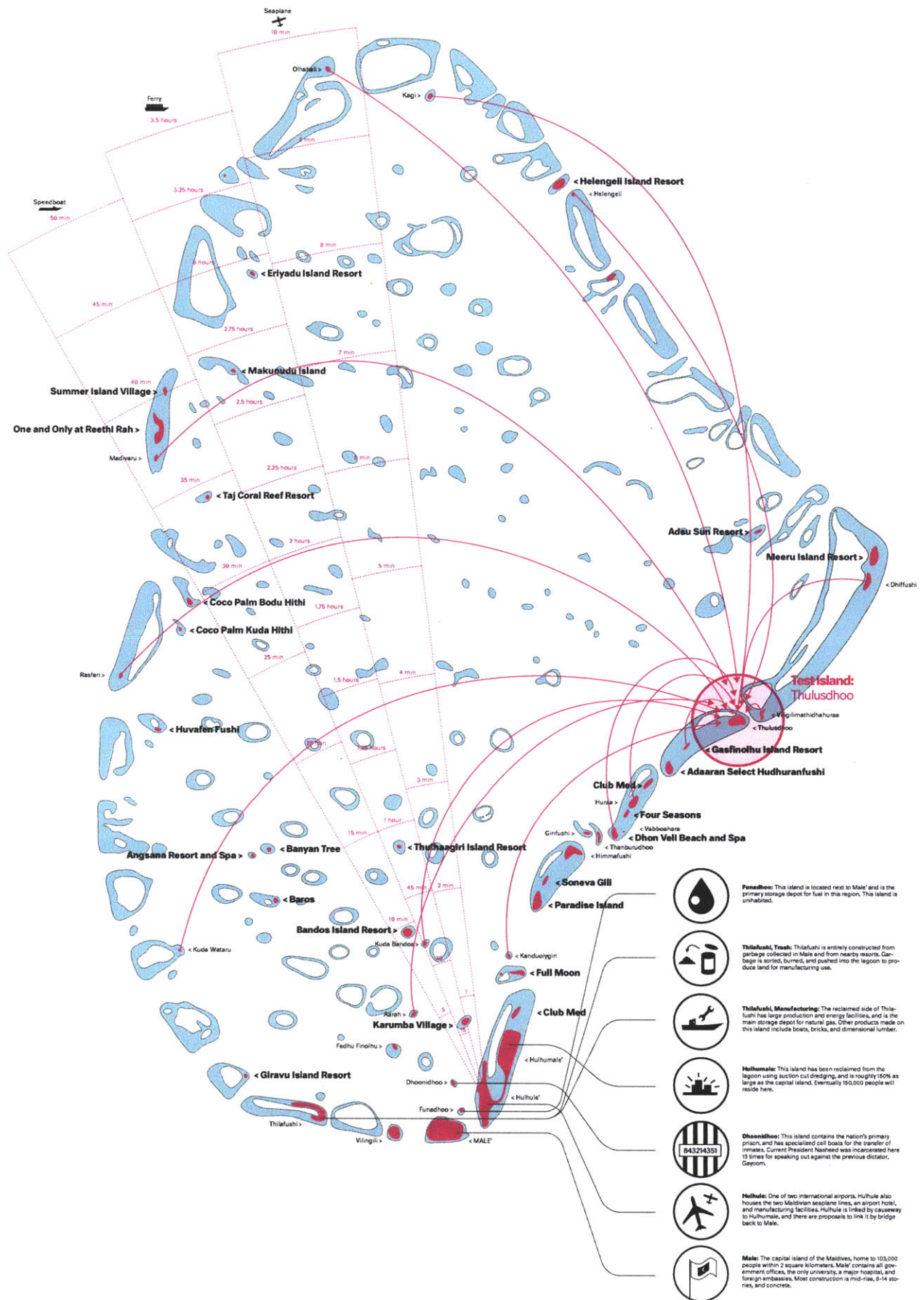
**Indian Ocean Tsunami**



**Tourist Arrivals by Month**

◀ Ahead of the 2009 Climate Change Conference in Copenhagen, President Nasheed staged an underwater cabinet meeting to ratify a declaration calling for global cuts in carbon emissions. Although events such as this have positioned the Maldives as the posterchild for countries vulnerable to climate change, they have had the detrimental effect of scaring off future investors into the tourism industry. Declarations that the country will disappear in the next 50 years are directly in conflict with the nations 50-year (minimum) lease agreements. Furthermore, as the steep decline in tourist arrivals after the 2004 Indian Ocean tsunami describes, consumer confidence is predicated upon the security of the country's tourism infrastructure.

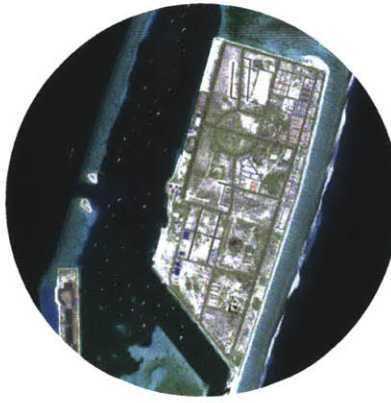




# Primary spending and civic infrastructure is constrained to capital city: the government is spread too thin for action!



Government



Housing



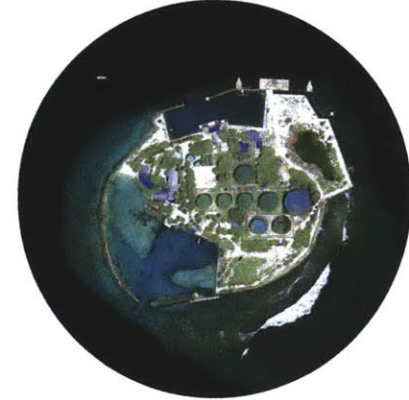
Waste & Industry



Airport



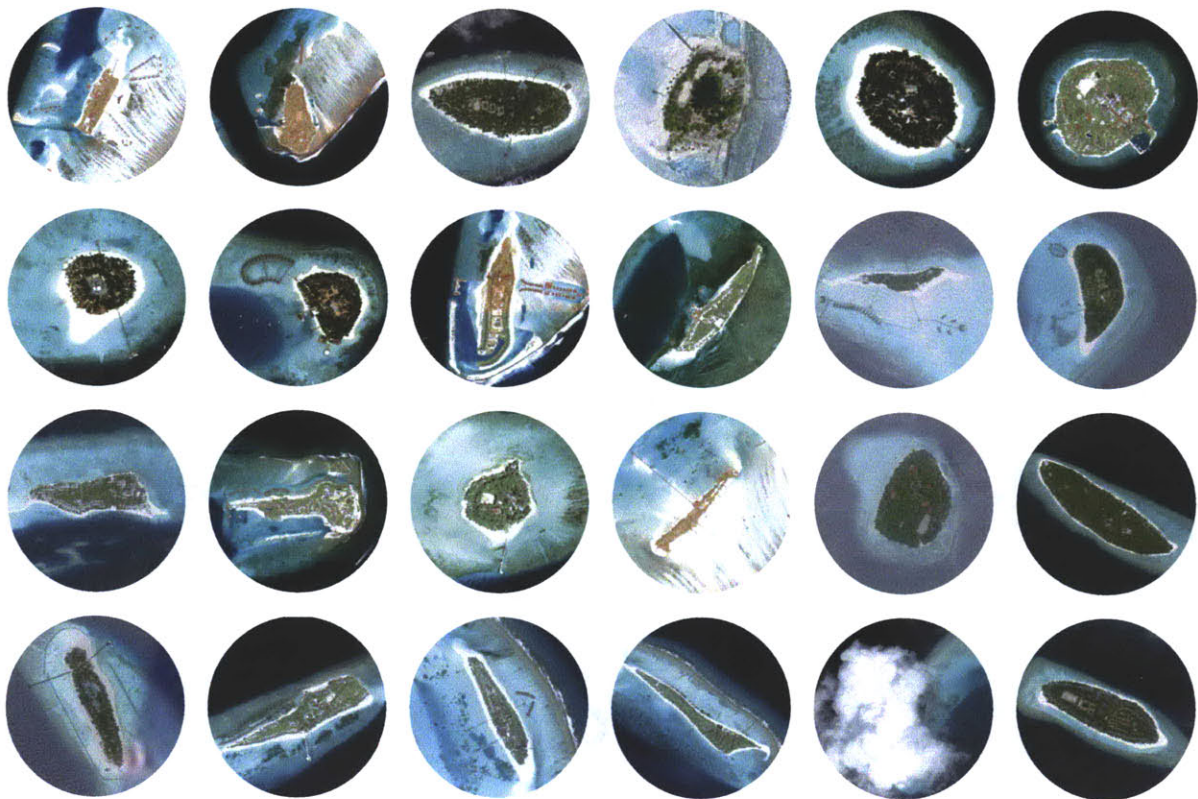
Prison

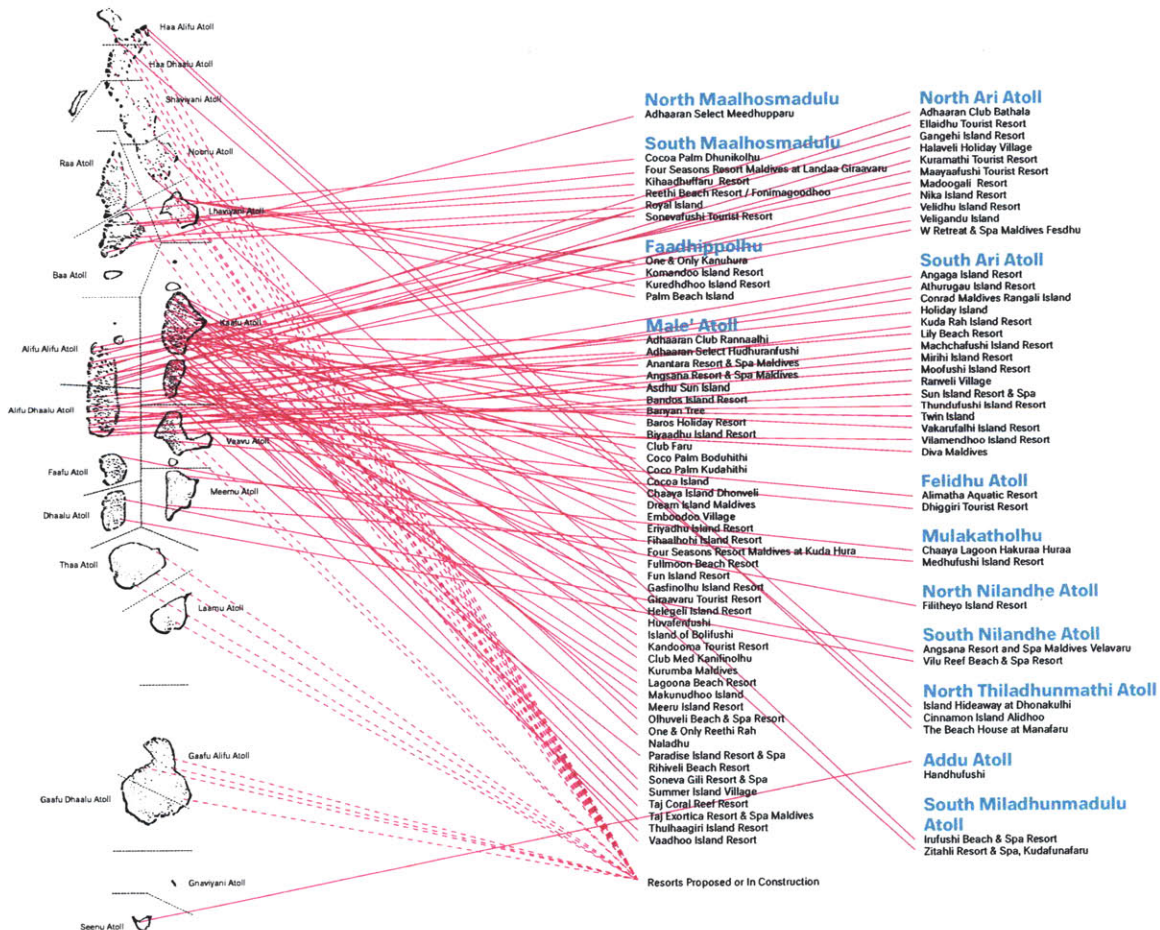


Fuel Depot



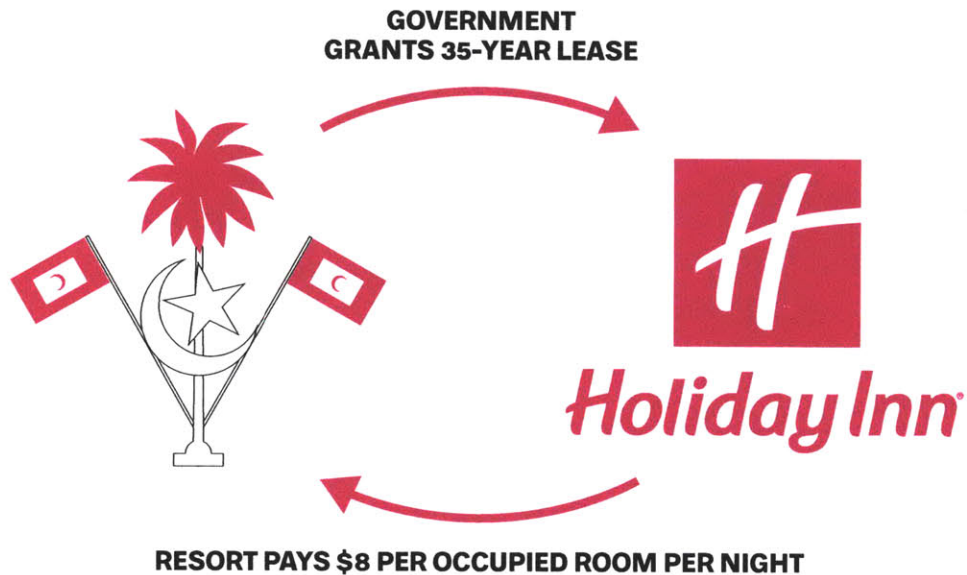
**Tourism operators  
are financially  
independent and  
geographically far  
flung: resorts provide  
a dispersed defensive  
infrastructure.**





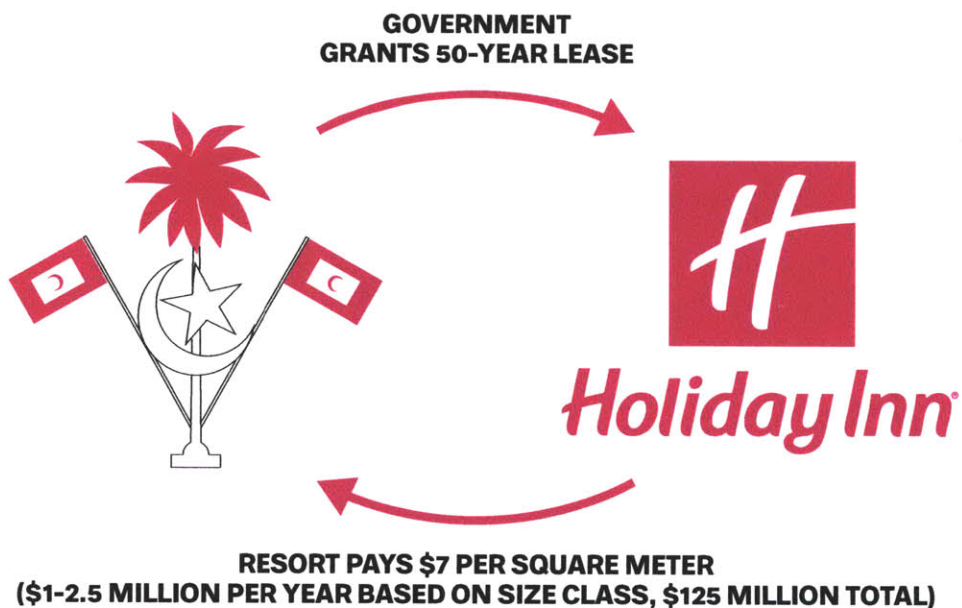


## Pre-2010: The Bed Tax



**SEEN AS DISINCENTIVE FOR EXPANSION BY RESORTS**

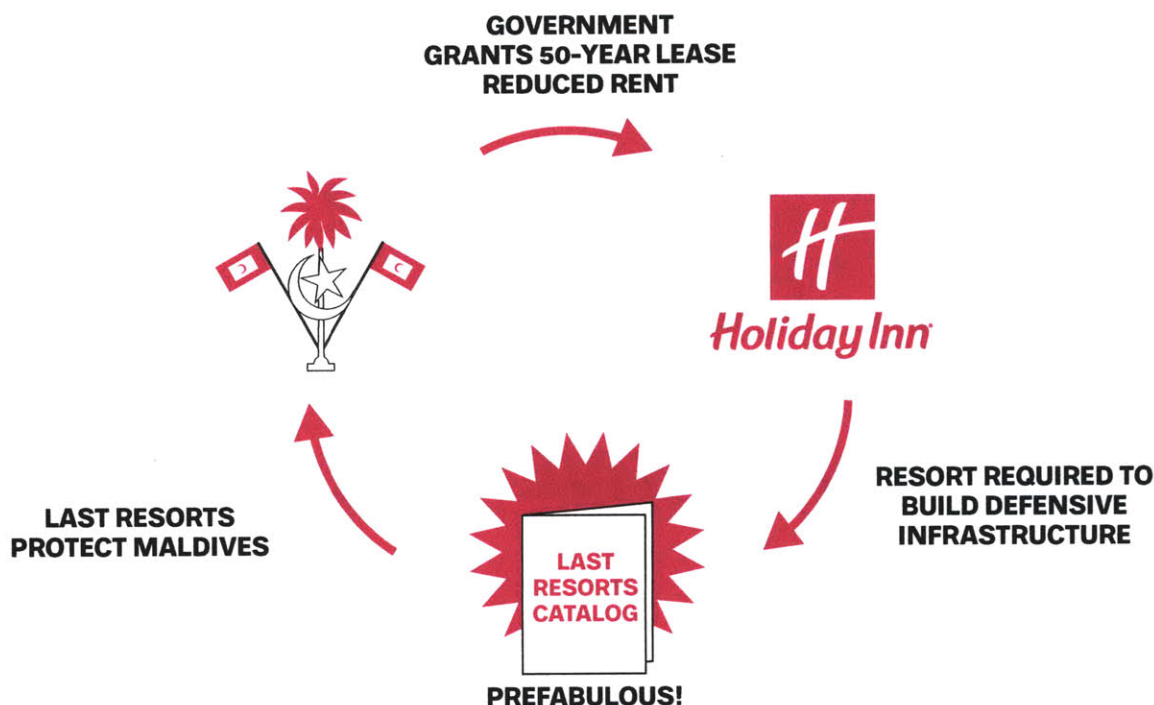
## 2010: The Tourism Act



**FLAT RATE SECURES OPERATIONAL CAPACITY**



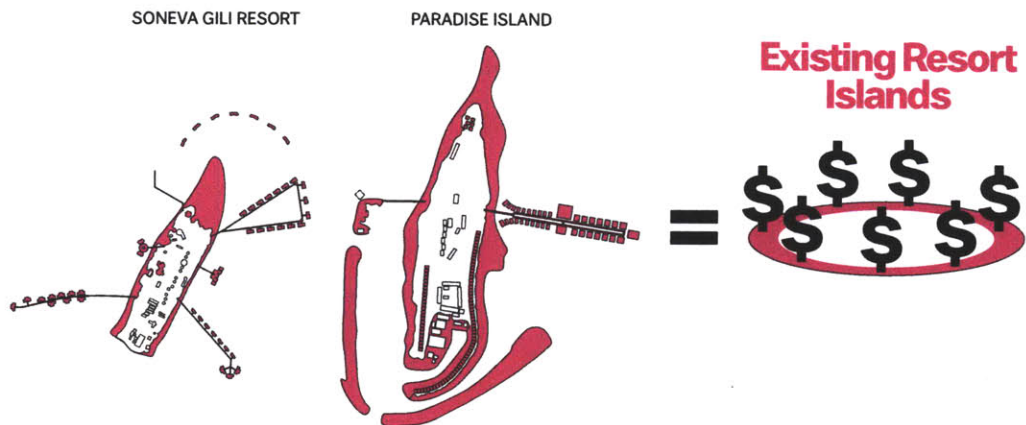
## Post-2010: Rent for Infrastructure



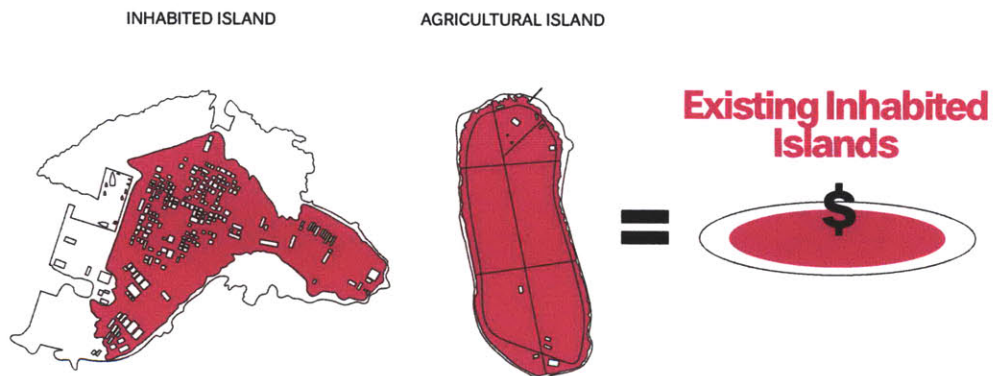
**DEFENSE BURDEN SHIFTED TO RESORT  
MORE RESORTS = AUXILIARY ECONOMIC INCREASE  
(CONSTRUCTION, TRANSPORTATION, JOBS)**

# The Maldives must rent for infrastructure!

Current rent structures commit resort operators to a 50-year lease, with an annual rent of \$1,000,000 to \$2,500,000 depending on the size of the island. Last Resorts proposes that instead of paying in cash, operators pay the government with DEFENSE, both hard infrastructure such as sea walls and jetties, and soft infrastructure such as beach building breakwaters and artificial reefs.



## LUCRATIVE EDGE

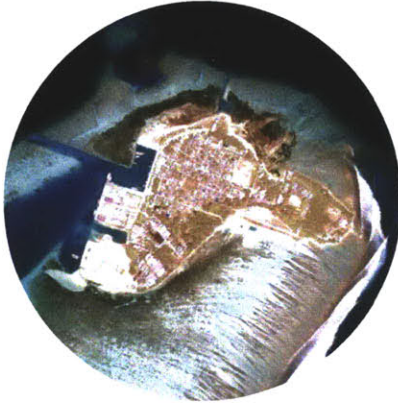


## PRODUCTIVE CORE

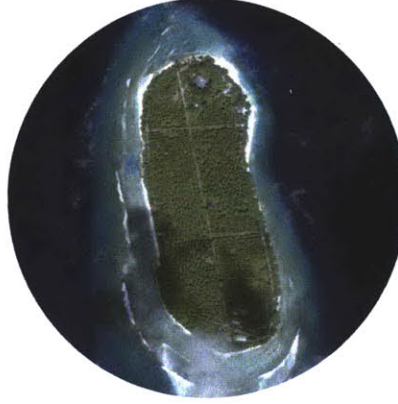


## RESORT TO THE RESCUE!!

- ◀ Existing inhabited islands can be typified by a developed core and an unoccupied perimeter that acts as a buffer zone against wave action and flooding. These “productive cores” house schools, workshops, hospitals, and housing. Resort islands are better described as a “lucrative edge” because guest rooms, dining, and other amenities are pushed to the exterior to take advantage of views to the reef and the horizon. The interior of resort islands are used for staff housing, water and electrical infrastructures, and other support features. These edge and core conditions are amenable to synthesis: resorts islands and local islands can combine to produce new hybrid types.



**Inhabited Islands:  
Cultural Tourism**

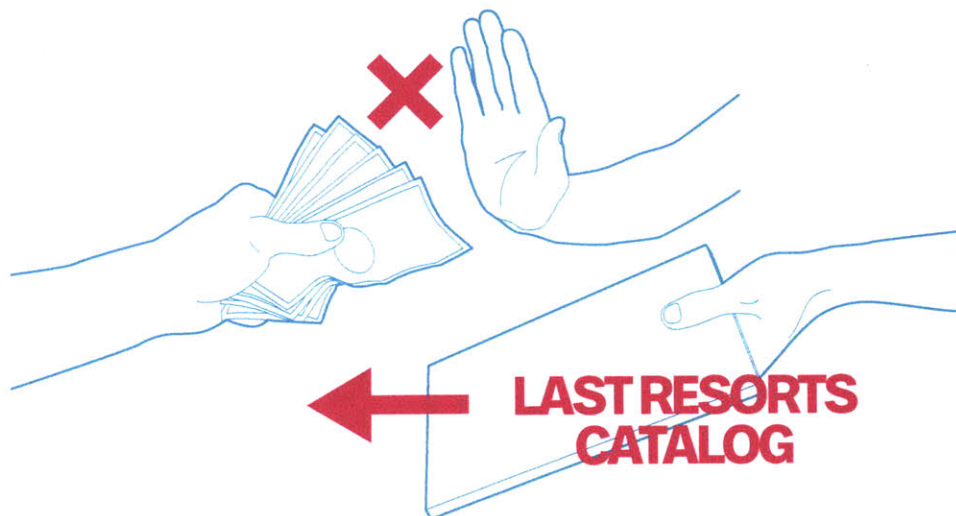


**Farm Islands:  
Agritourism**



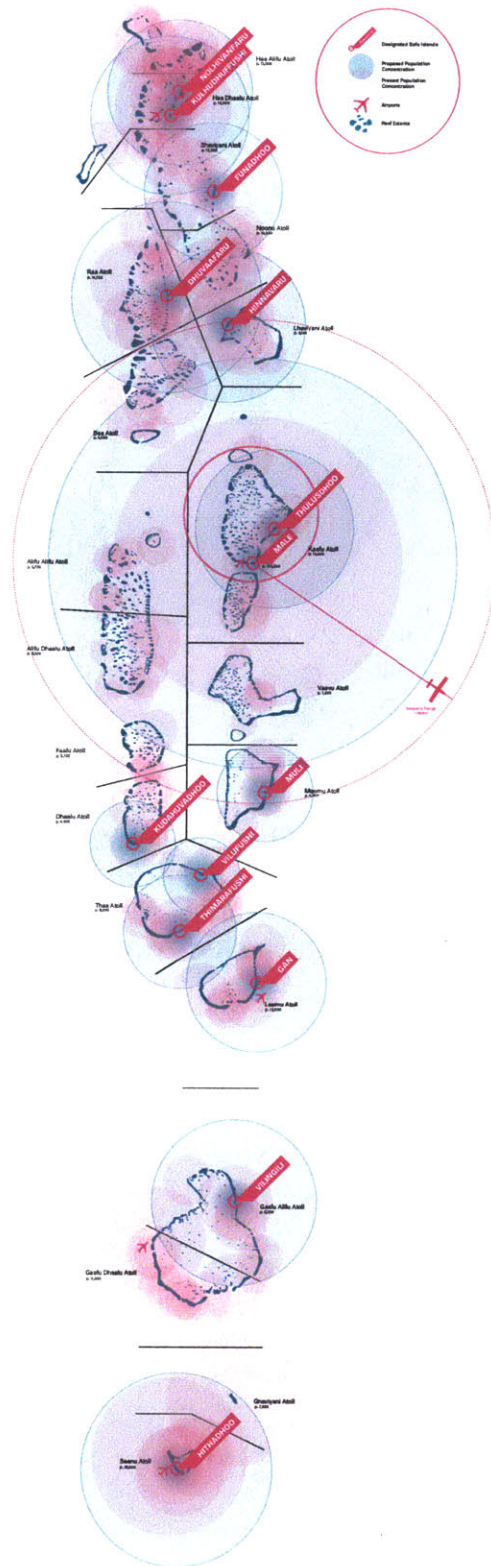
**Capital Island:  
Urban Tourism**

- ▲ By wrapping themselves around existing inhabited and agricultural islands, Last Resorts can defend the Maldives and create new typologies hospitality: farms become agritourism, towns become cultural tourism, fishing villages become an angler's paradise, and artificial reefs will produce the best diving in the Indian Ocean. Last Resorts will expand the nation's economy, ensure Maldivian sovereignty, and protect the archipelago's ecology.

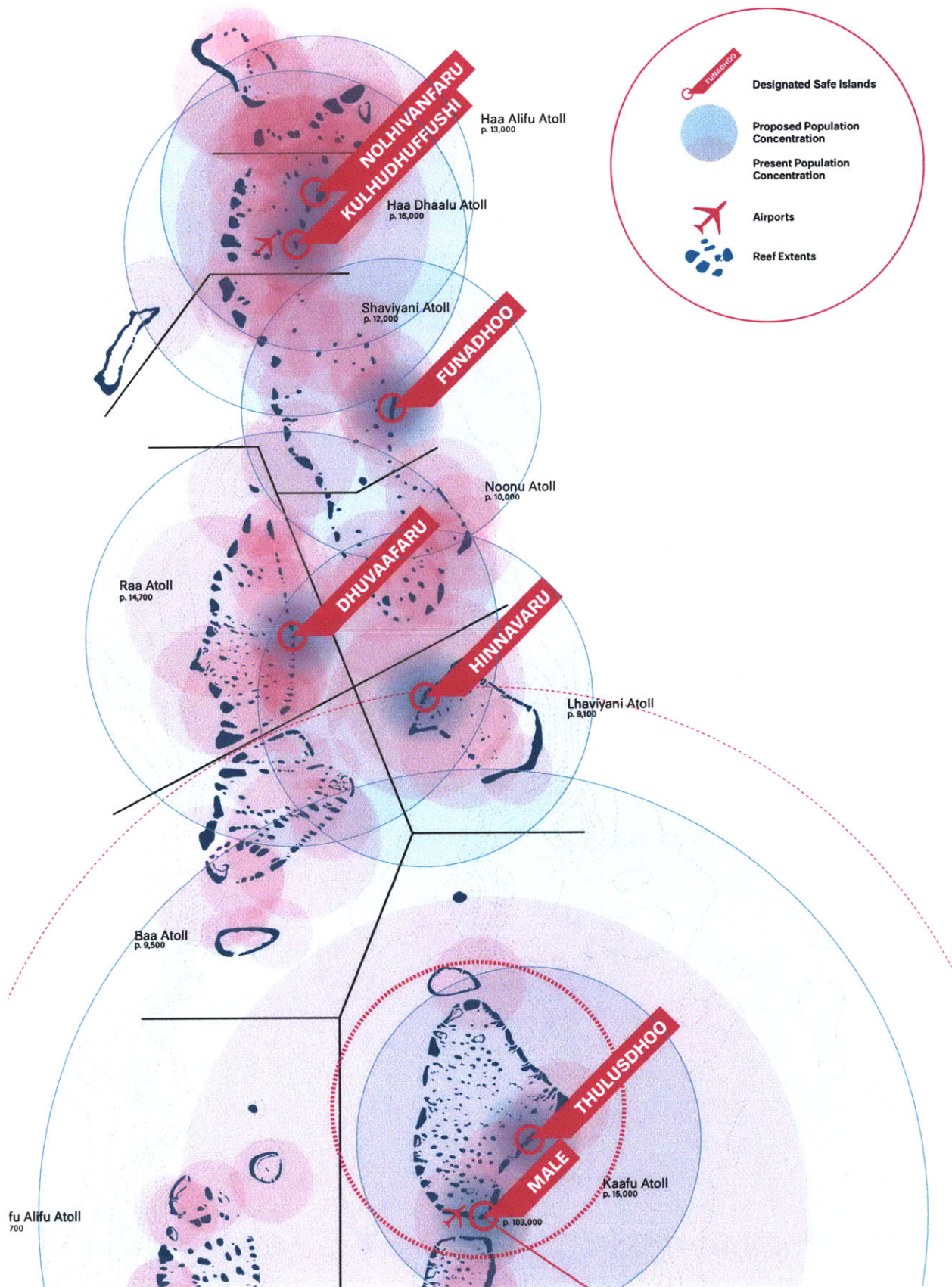




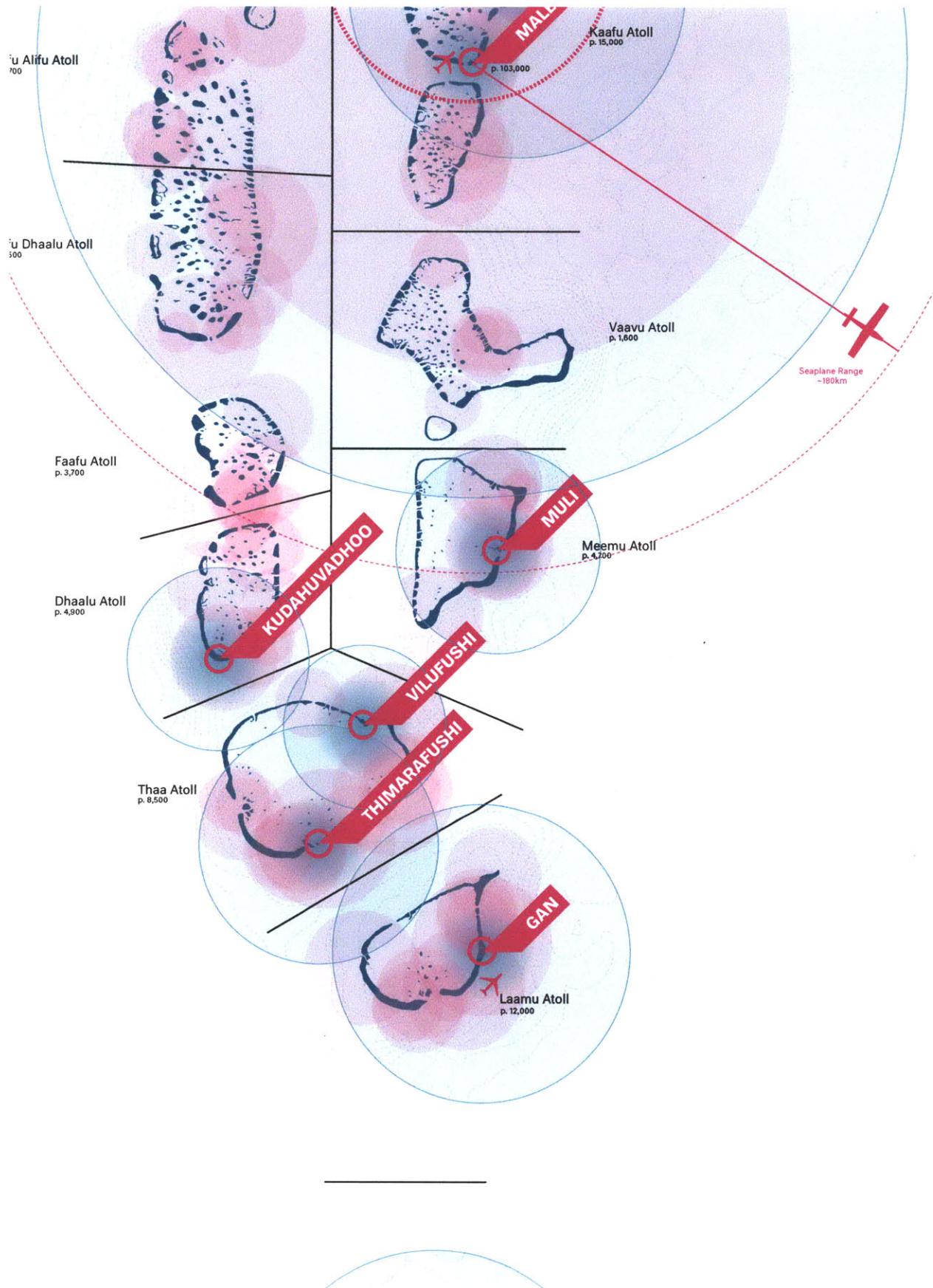
# Distribution Solution

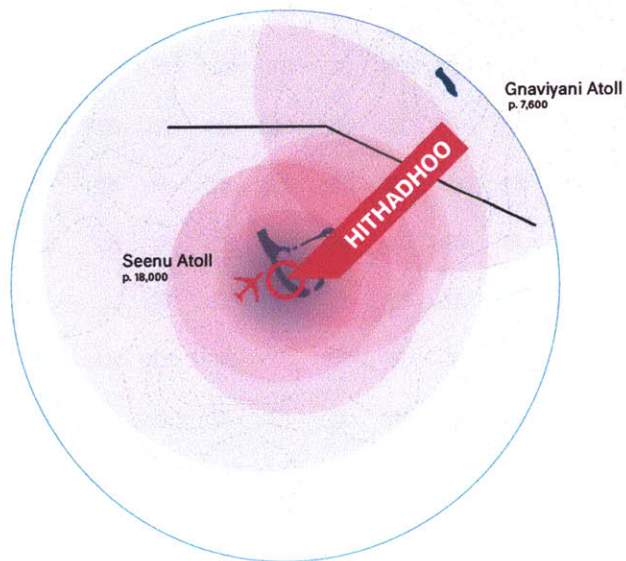
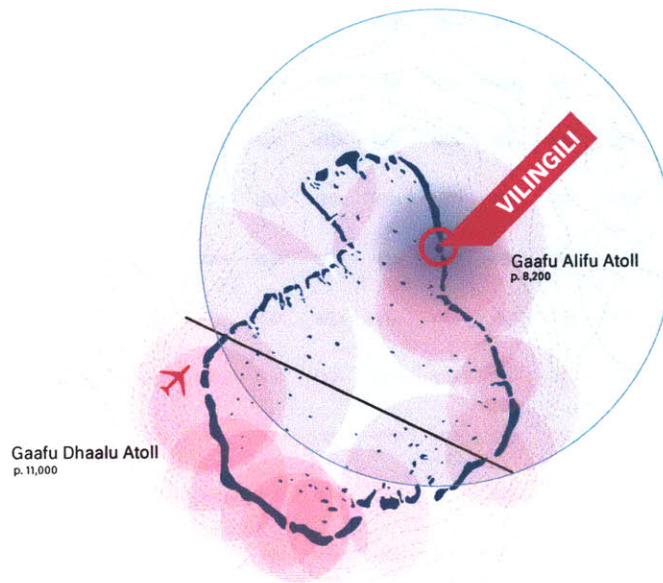


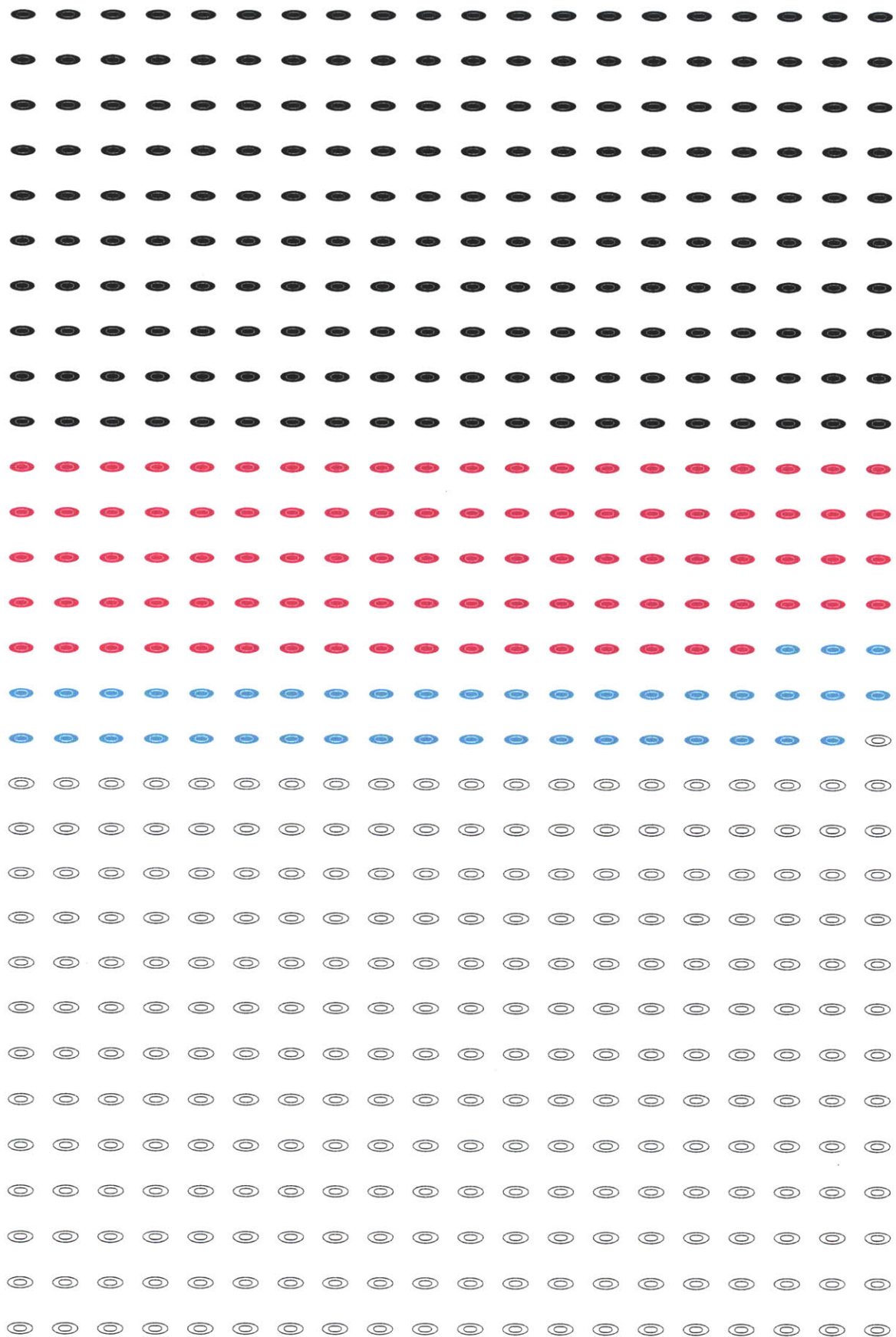
The Maldivian Archipelago stretches 900km from north to south, and is comprised of 1,190 charted islands. (An island is anything with at least one tree, thus differentiating between islands and sandbars) Of these 1200, 200 are occupied, 42 are utilized for agricultural purposes, and 97 contain resorts. The rest are uninhabited. At present, population is distributed throughout 27 atolls, although the majority of civic infrastructure is collected in the islands surrounding the capital of Male' in Kafuu Atoll. **Following the 2004 tsunami, the government identified 14 tsunami "safe" islands to be fortified against future inundation. These islands are selected as they already have large populations and critical infrastructures such as hospitals, schools, and government offices.** This map demonstrates the proposed shift in population distribution: today in pink, tomorrow in blue. As demonstrated in further chapters, the fortification of each island can be achieved by the integration of durable and defensive Last Resorts.













**The Maldivian  
Archipelago is:**

**1190 islands**

**200 inhabited**

**97 resort**

**42 agricultural**

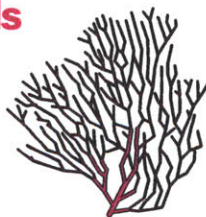
# Alternative resources can replace the dearth of local materials: monsoons, trash, and artificial reefs present opportunities for eco-infrastructures

## Primary Local Materials



### Sand:

Most islands in the Maldives are comprised of calcium carbonate sand, a product of eroded corals. Sand mining is illegal in the Maldives due to material scarcity.



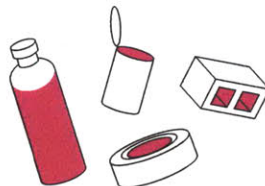
### Coral:

Traditional buildings in the Maldives are constructed from mined coral, which can be cut into blocks and ornately carved. Coral mining is now illegal due to the fragility of the local ecosystem, and the importance of the reef for tourism.



### Cellulose:

Primarily palm trees and mango wood, used in traditional dhoni fabrication, roofing, and simple housewares. Trees are extremely scarce.

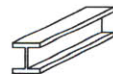


### Trash:

All trash from Male' and the Maldives' 97 resorts is boated to Thilafushi, where it is used as fill or recycled. Of special note are plastics, which can be reformed into building units.

## Primary Imported Materials

### Steel



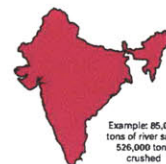
**2008:**  
942,000 tons of steel imported



### River Sand

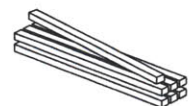


**2008:**  
4,727,000 tons of mineral (sand, aggregate) imported



Example: 85,000 tons of river sand  
538,000 tons crushed aggregate  
from India

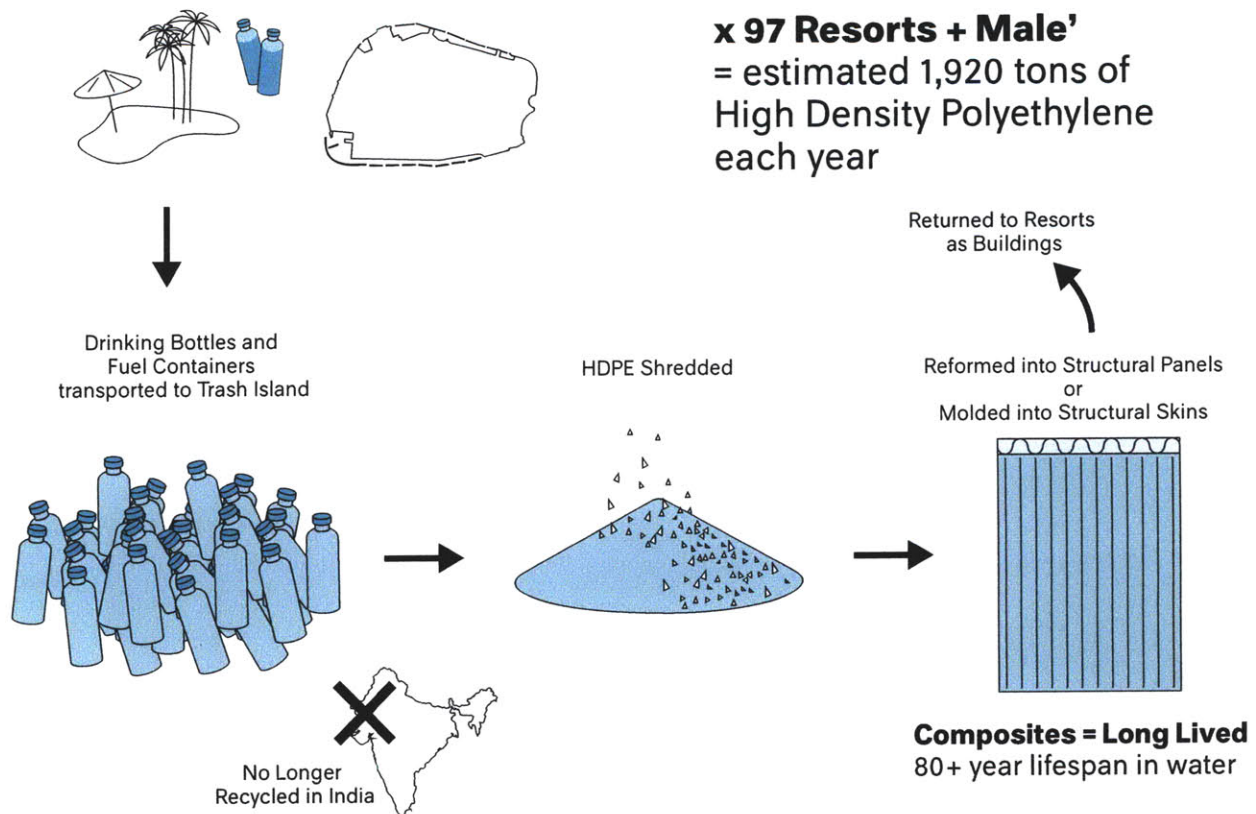
### Hardwood



**2008:**  
884 metric tons of wood imported



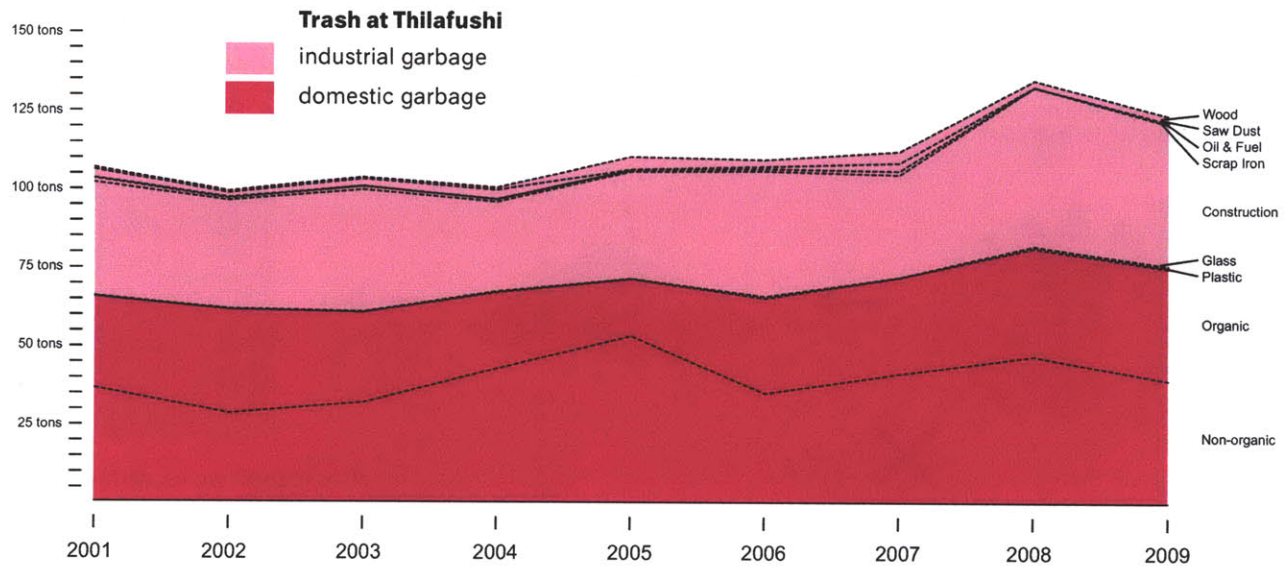
Example: all building materials for Soneva Gili resort imported from Thailand



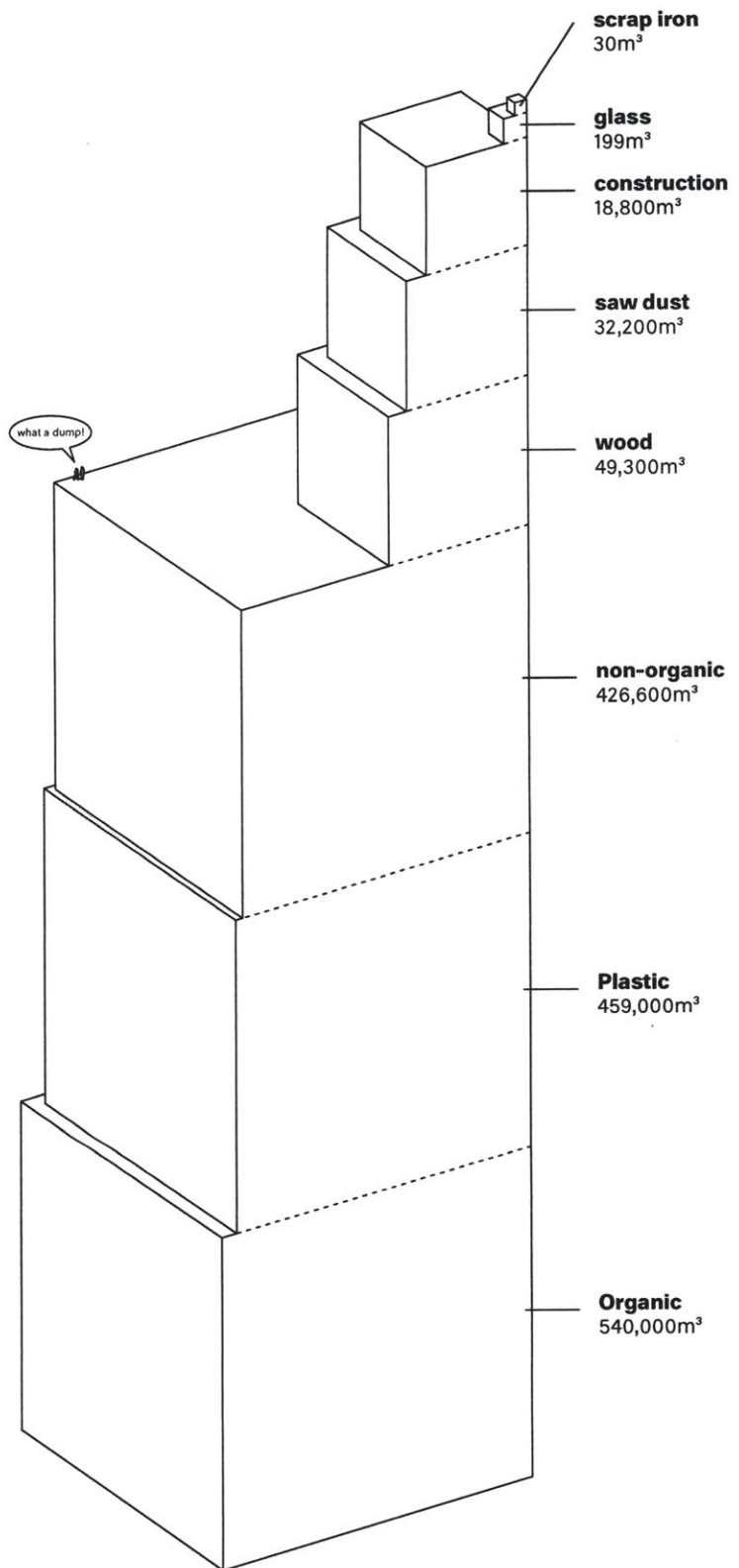
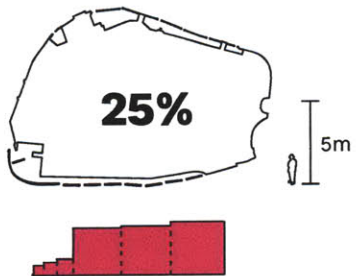
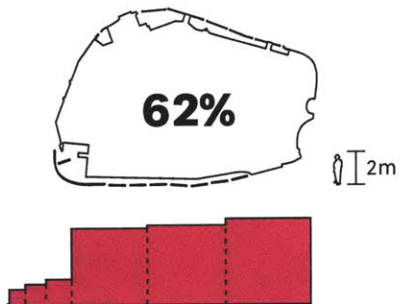
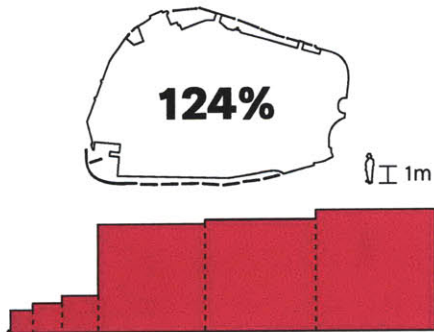
**Discarded plastics  
from resorts are  
upcycled into durable  
composites for sea  
wall construction and  
resilient architectures**

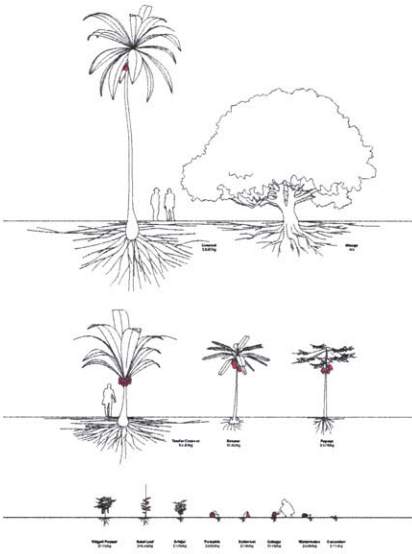


In 2009, over 279,000 tons of garbage was distributed to the island of Thilafushi: more than half came from resorts, and the rest from Male', Hulhumale, and the airport. Thilafushi is an island completely reclaimed from the reef by piling trash into shallow waters, producing an island of roughly 30 acres which is now used for manufacturing and natural gas storage. These strategies of land reclamation can be used locally on Last Resort islands: trash can be sorted and disposed of locally by filling composite sea walls which will assist in the accumulation of sediment from seasonal monsoon action as well as the strategic redistribution of soil from one part of the island to another. (see Beach Builders and Potted Palms)

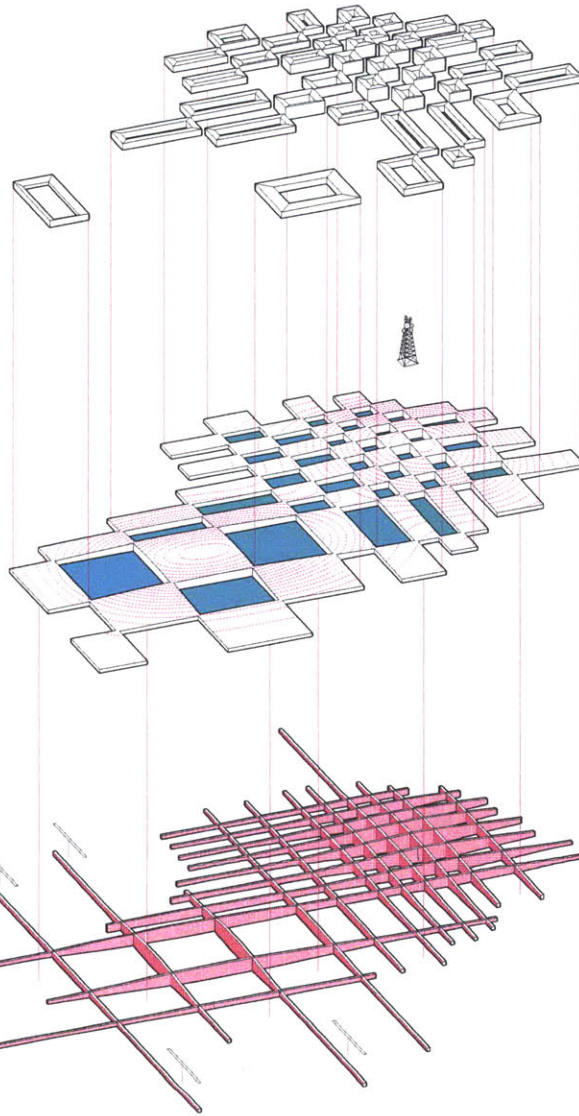
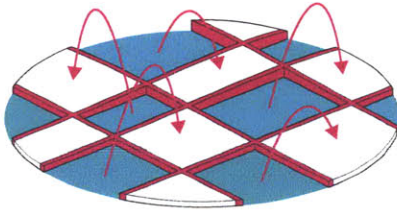


**Each year, resorts and Male' produce 279,000 tons of trash, enough to raise the entire capital by 1.25 meters!**





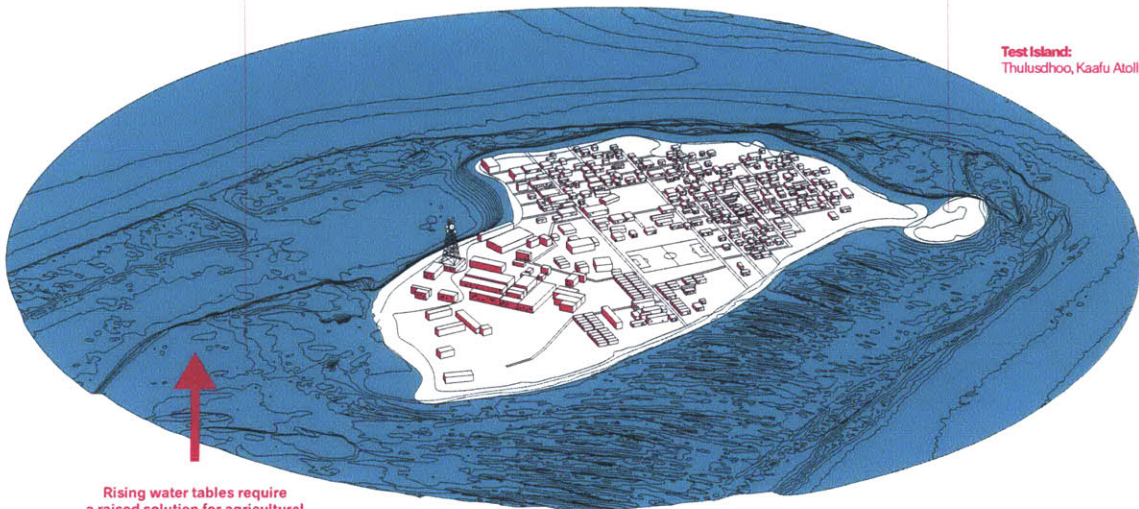
**lower your  
sodium today!**



a 10-meter wall can  
be yours for only:  
**\$990**  
per foot!  
(installed)



total cost of infrastructure,  
as shown:  
**\$79**  
million



**Test Island:**  
Thulusdhoo, Kaafu Atoll

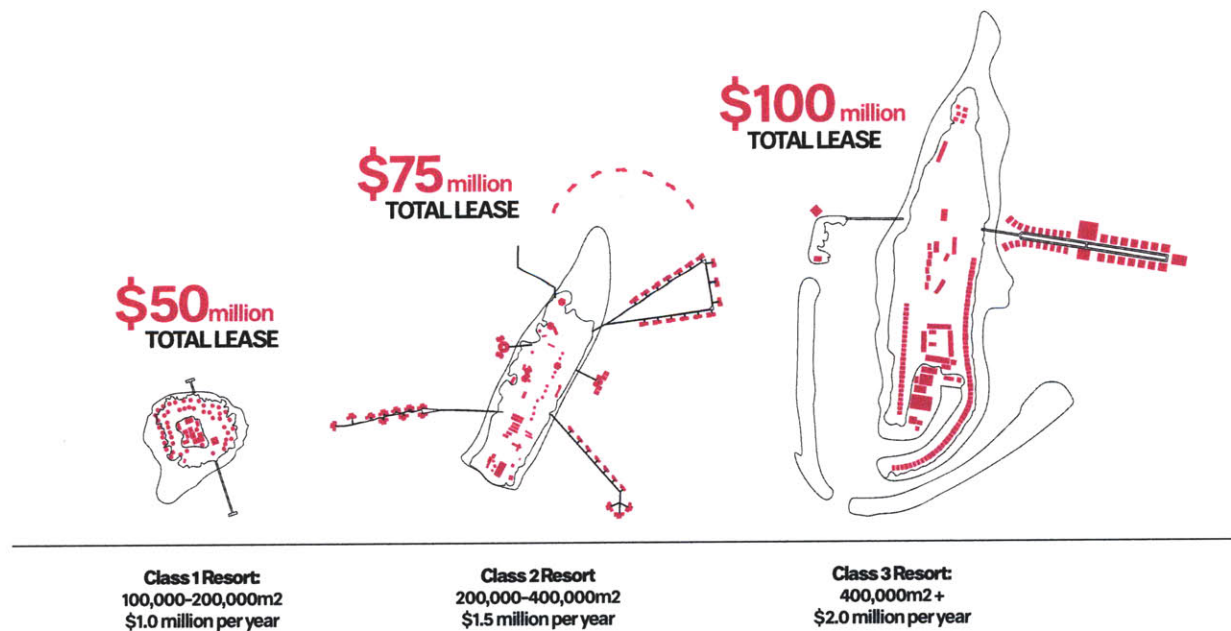
Rising water tables require  
a raised solution for agriculture!

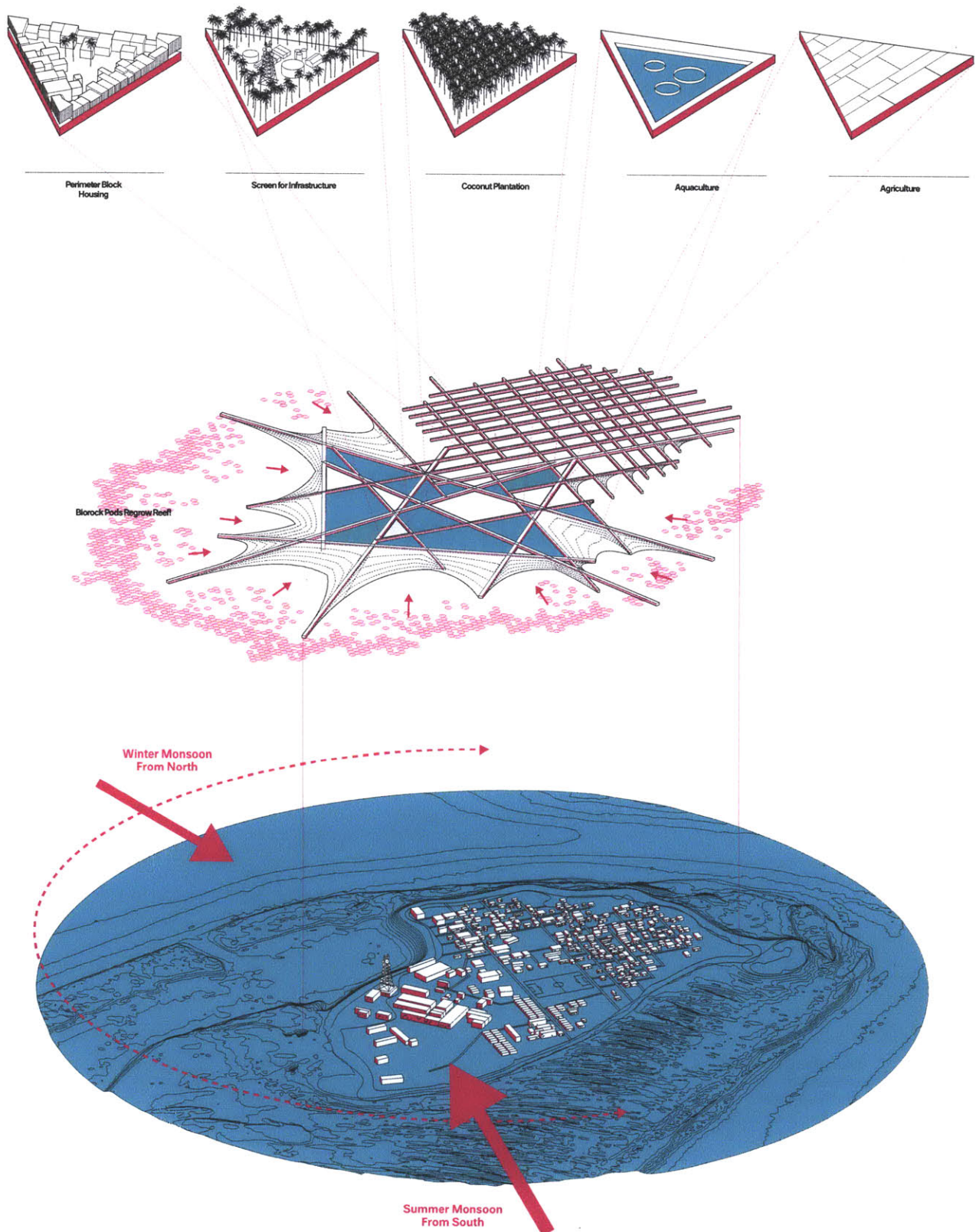


# Potted Palms

< The following test cases are deployed on the island of Thulusdhoo, one of the 14 “tsunami” proof islands identified by the Maldivian Government. The Potted Palms strategy deploys composite sea walls across established island communities such that fill and soil can be strategically moved between adjacent parcels to produce wave and flood proof land raised above the rising saltwater table. The landscape can be raised based on root depth for various crops: mangos and coconuts grow best with soil depths over 4 meters, while smaller varieties of pumpkin and pepper grow in depths of less than 1 meter. Excavated areas can be used for high density aquaculture. Larger and smaller areas correspond to municipal and residential parcels. Sea walls follow existing roads, reducing complications during implimentation and preserving the basic parameters of established urban patterns. The existing perimeter block typology found on most islands can be maintained as space and scale require.

**Sheet piling is implementable by small construction crews: sea walls can be added incrementally to fully secure the islands. Strategic land packing and unpacking creates arable land for agriculture**



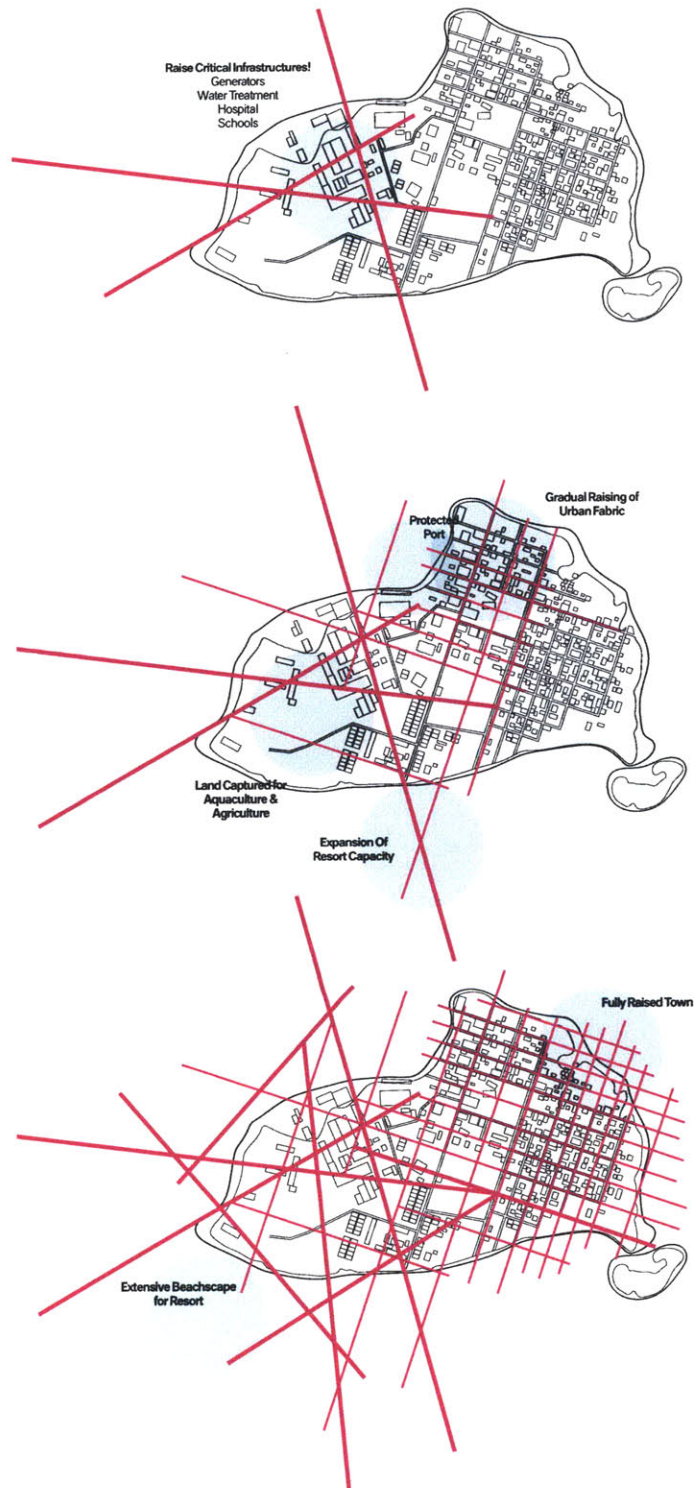




# Beach Builders

< Regions captured by seawalls can be programmed either for high-density development or for a variety of productive and recreational landscapes. These include ponds for aquaculture, pools for swimming, orchard groves, agricultural fields, operational infrastructure such as sewage treatment and power generation, and finally, perimeter blocks of housing and commercial buildings. Services can be shared by the local population and the resort; additionally, the economy of the island is supported by jobs at the resort and by visitors to local retail and cultural establishments.

> Infrastructure will be deployed incrementally, beginning by securing critical water treatment, energy, and communications services. As resorts expand their operational capacity, further seawalls can be laid down. Housing will occupy the base and ends of piers, while other island functions can occur in the (now protected) core of the island. As sea levels rise, the original shoreline will be obscured, and the new island perimeter will be defined by constructed beaches and sea walls that allow the island to expand to the extent of each reef's shallow waters.

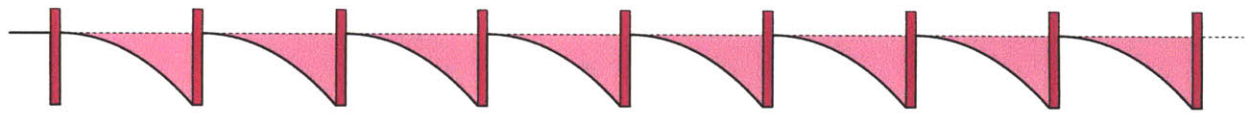




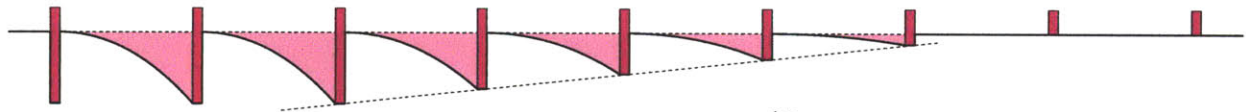
Although initially destructive, sea walls are necessary to protect islands from flooding and rising salt tables in the ground water. These walls can be deployed to produce large and small internal pockets, either filled and used for housing or agriculture, or evacuated and filled with water for recreation and aquaculture. Extended piers capture beach material from rebuilt reef systems, creating a constructed edge that can be used as tourist beaches or as a harvesting point for sediment to be moved inland.



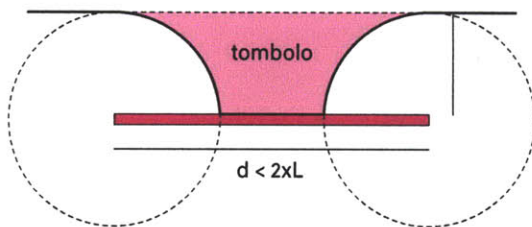




Spacing = 1:2

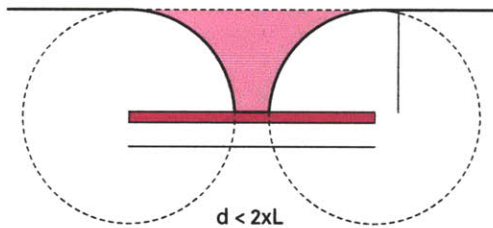


6 degree decrease reduces downdrift erosion

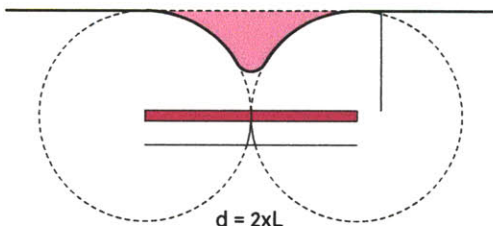


$d < 2xL$

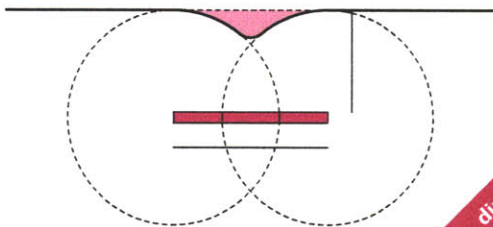
where  $d$  = distance from shore  
and  $L$  = length of breakwater



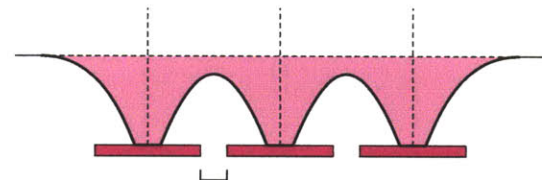
$d < 2xL$



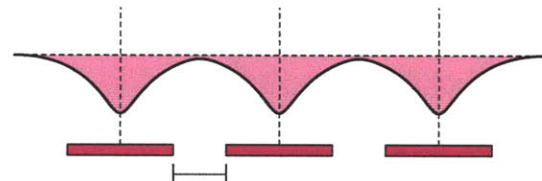
$d = 2xL$



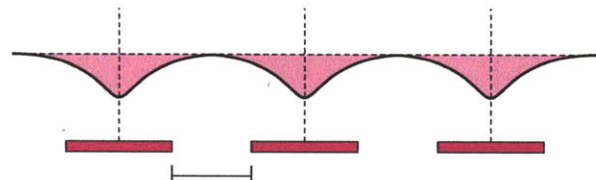
$d > 2xL$



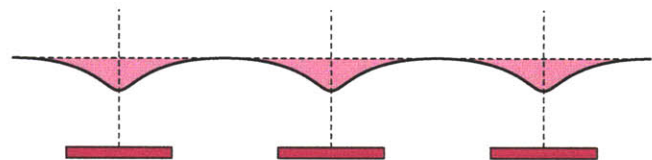
25% Exposure Ratio



50% Exposure Ratio



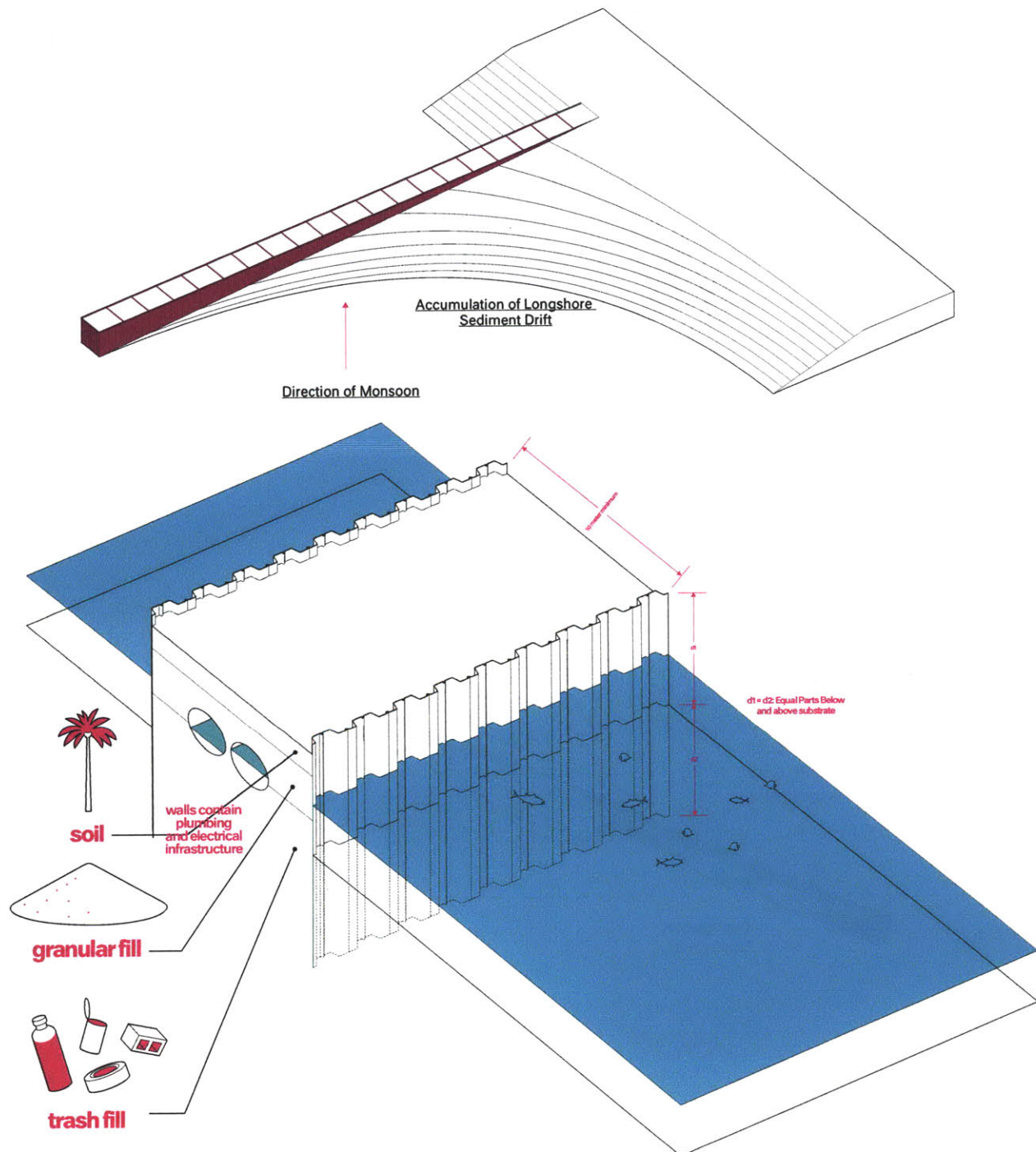
75% Exposure Ratio



100% Exposure Ratio

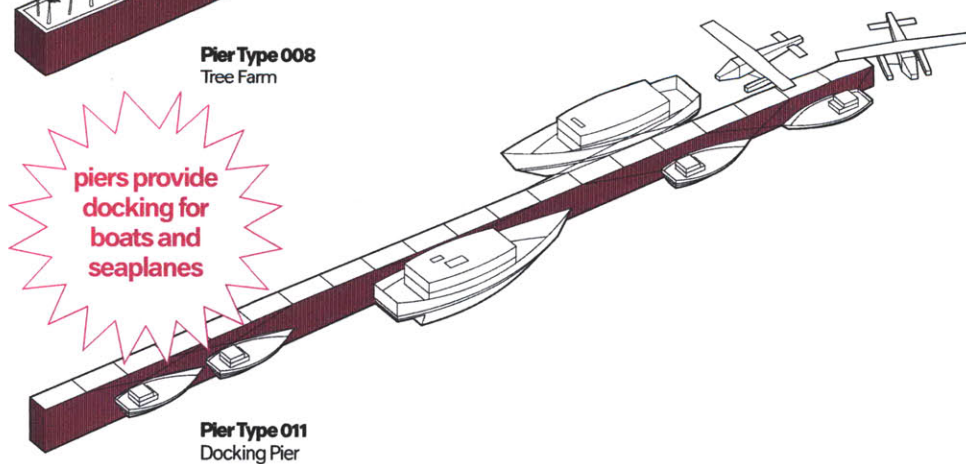
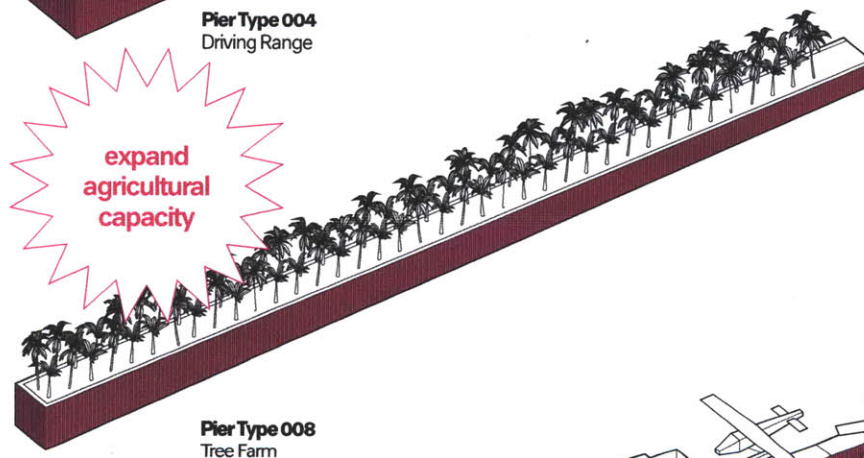
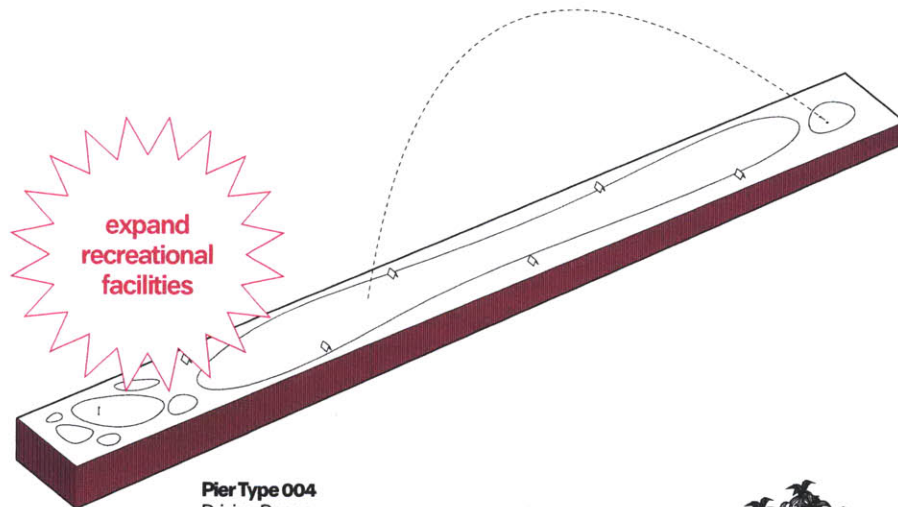


Composite sheet pilings filled with trash or sand can be deployed perpendicular to the shoreline to produce a series of beach catching groynes. Typically a groyne is positioned such that the direction of wave action is at a 45 degree angle, forming a pocket. However, because the seasonal monsoon winds shift dramatically throughout the year, this direction of greatest wave incidence is taken to be from the north west, west, and south. By positioning a detached breakwater or underwater sill directly offshore, wave action will collect sediment in a berm or trombolo. This sediment is a product of the regions extensive coral reefs, and typically shifts from one side of the island to the other throughout the year.



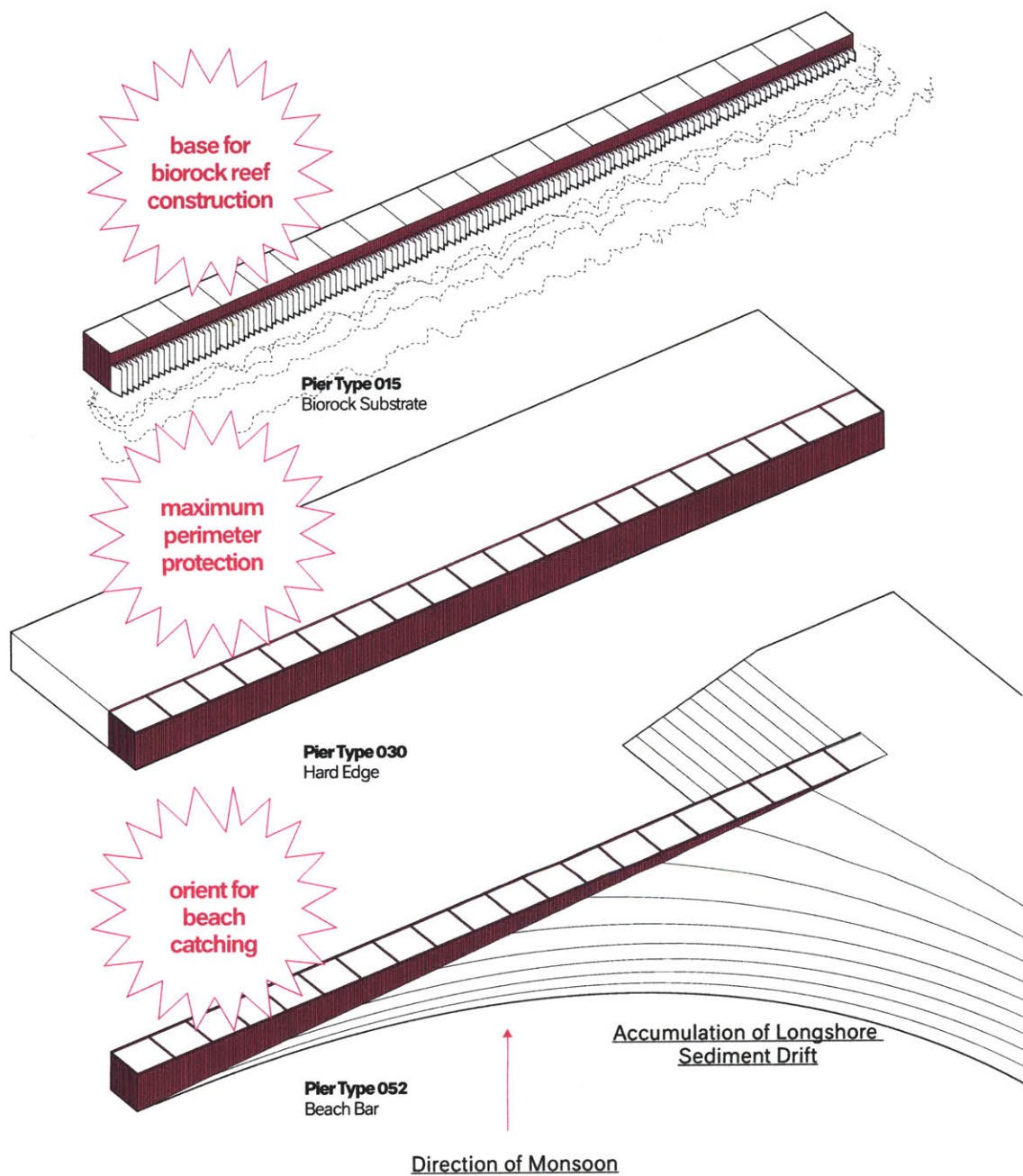


# Pier Types

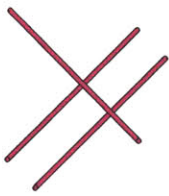
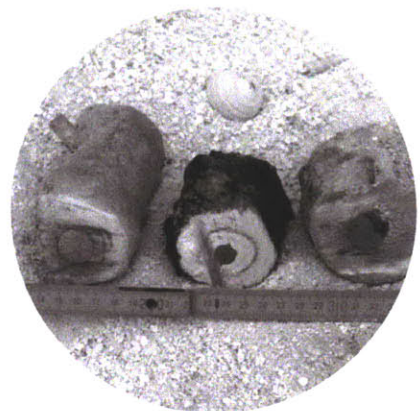
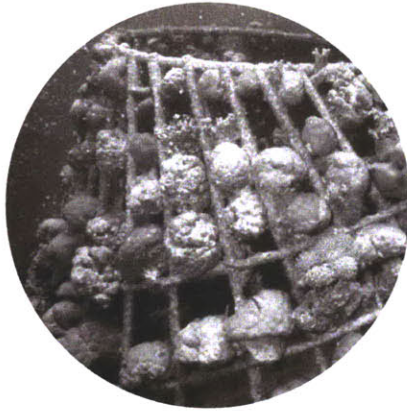


**only \$1000 per foot!**

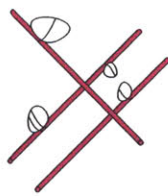




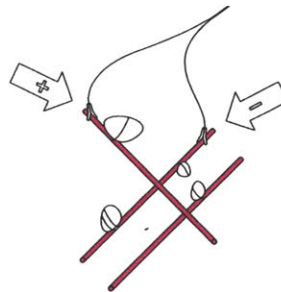
photos: <http://www.globalcoral.org/>



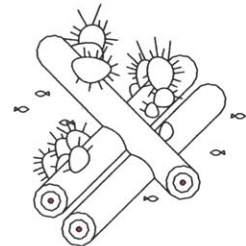
1. Steel Substructure



2. Live Corals Attached With Wire



3. Direct Current Applied

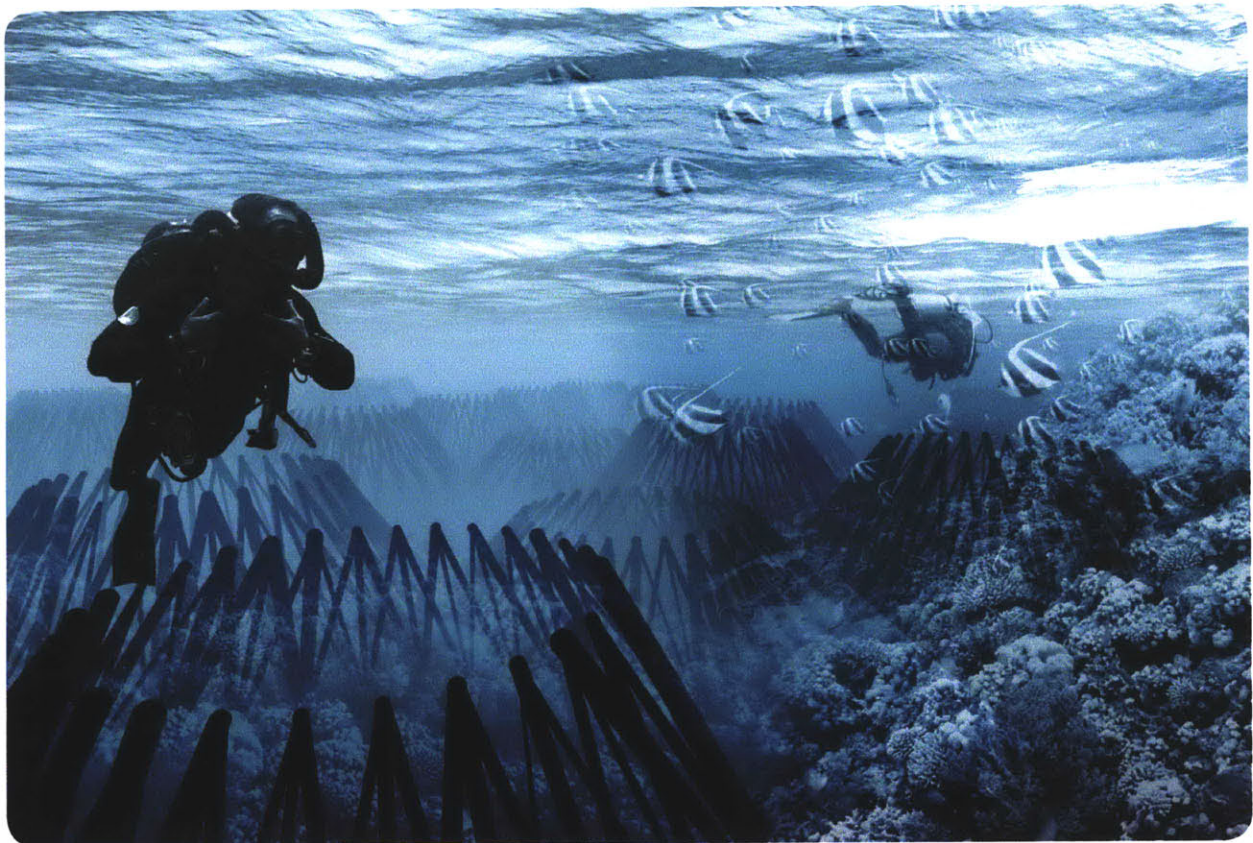
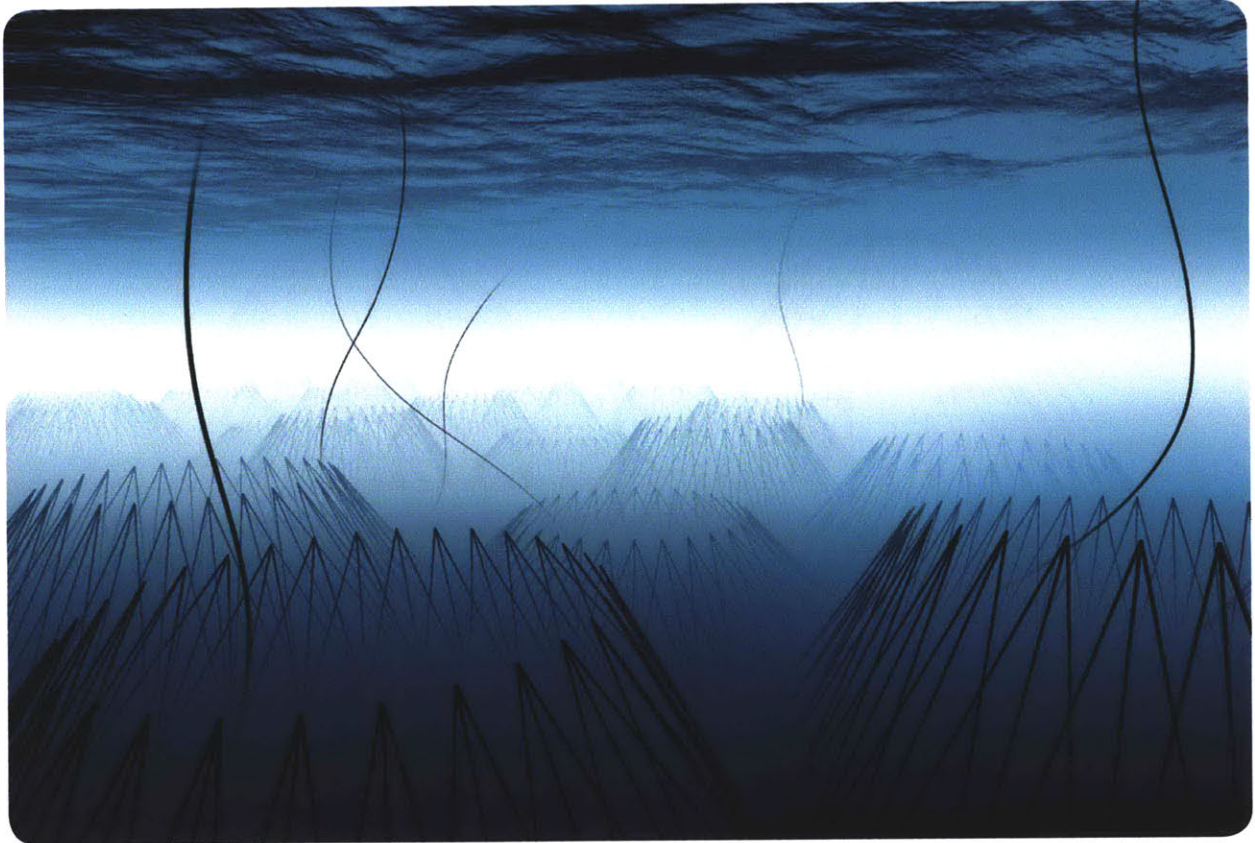


4. Reef Grows 2cm per year

**1 kwh = 1 kg  
Calcium Carbonate**

The expansion of islands through dredging and bleaching from rising ocean temperatures has compromised the extensive coral reefs of the Maldives both in terms of their capacity to generate the sediment which is responsible for the creation of the islands, and the biodiversity which attracts tourism and industrial fishing. These reefs can be strategically rebuilt through the application of BioRock technology, a reef restoration process developed by Wolf H. Hilbertz by which calcium carbonate accumulates on steel once an electrical current is applied. For every kilowatt hour of electricity, one kilogram of limestone-like material is produced, and can grow with three times the strength of portland cement at a rate of 2cm per year. Young corals feeding on the calcium carbonate are encourage to grow up to four times faster than in typical situations. In isolated instances, artificial reefs can be used as tourist attractions or seeds for environmental replenishment. In linear deployments the reefs can be used to create defensive sills, or underwater breakwaters, which can defend islands from increased wave action, and will continue to grow upwards and become more robust as sea levels rise. Finally,



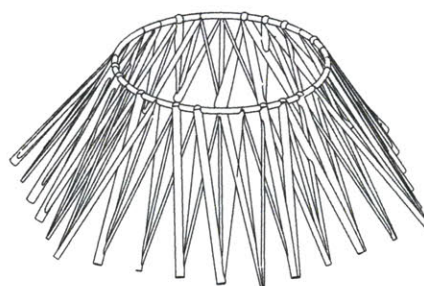




# Reef Pod Deployments



At Installation



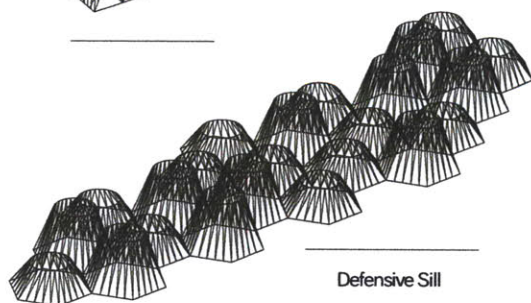
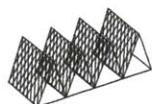
+ 5 Years



S,M,L Single Pods



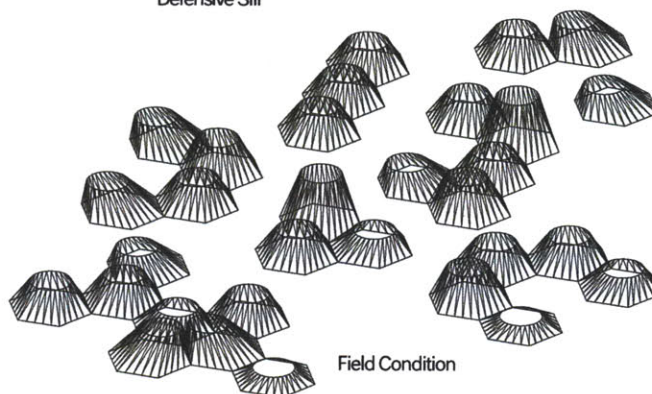
TriplePod



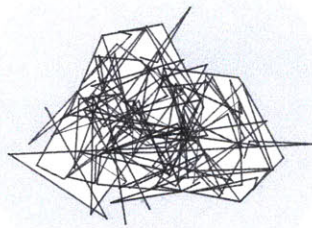
Defensive Sill



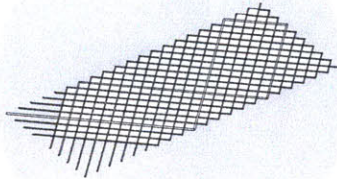
Diving Node



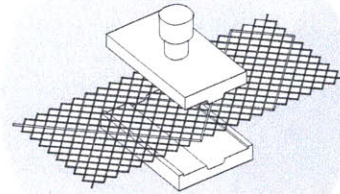
Field Condition



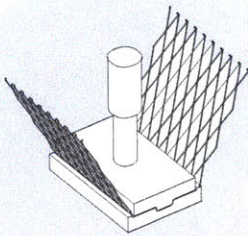
1. COLLECT  
SCRAP STEEL



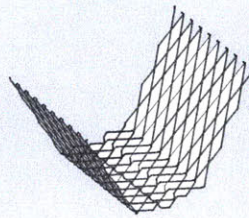
2. FLATTEN INTO  
CRUDE MESH



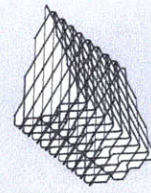
3. STAMP



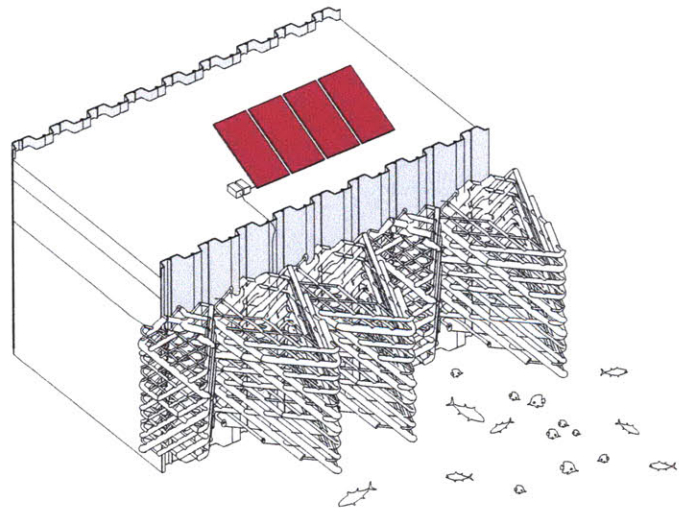
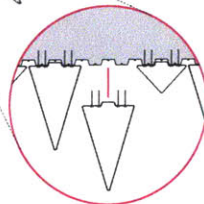
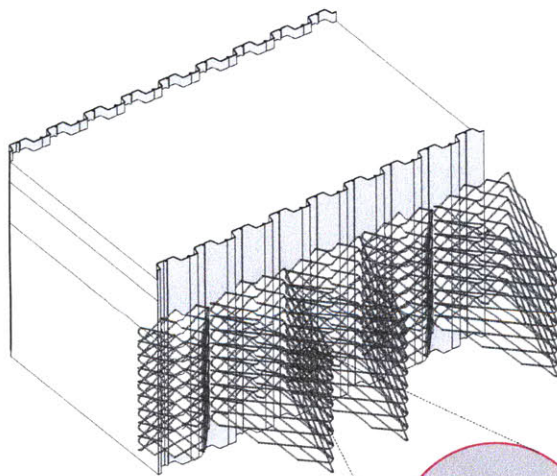
4. STAMP



2. PROFILED TO  
FIT PILINGS



3. FOLDED TO  
MAKE RIGID



Scrap metal salvaged from the trash island can be straightened and stamped into structurally stiff units designed to marry with sheet pilings on the composite walls. In this way sea walls provide physical defense and active ecology.





Calm days offer unprecedented occupation of the reef far from shore.

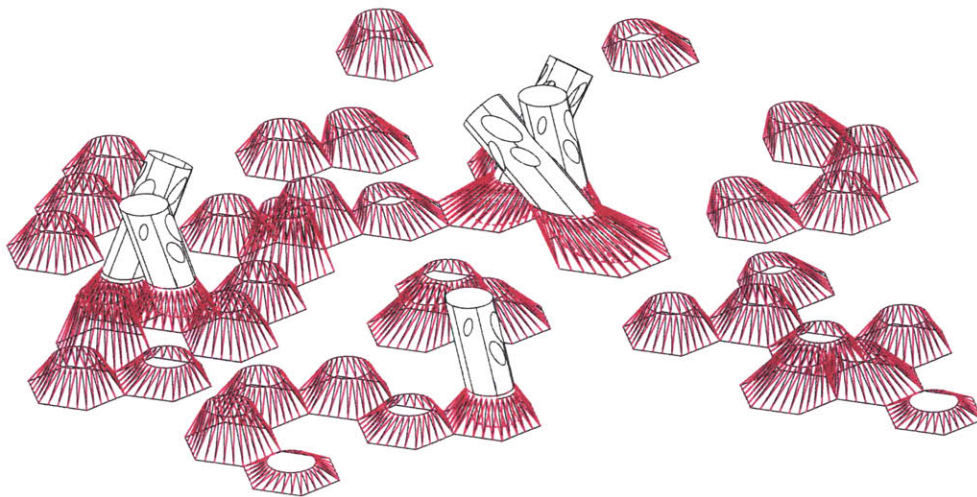


Stormy days are spent cuddled up inside!

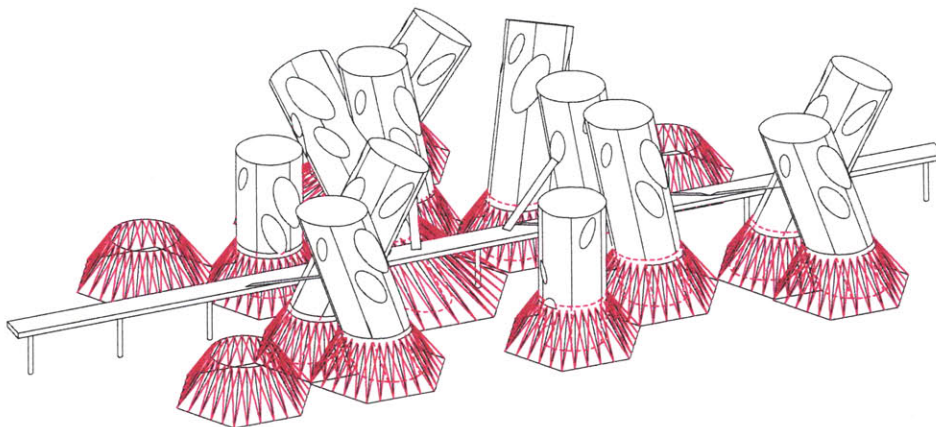


# Breakwater Bungalow

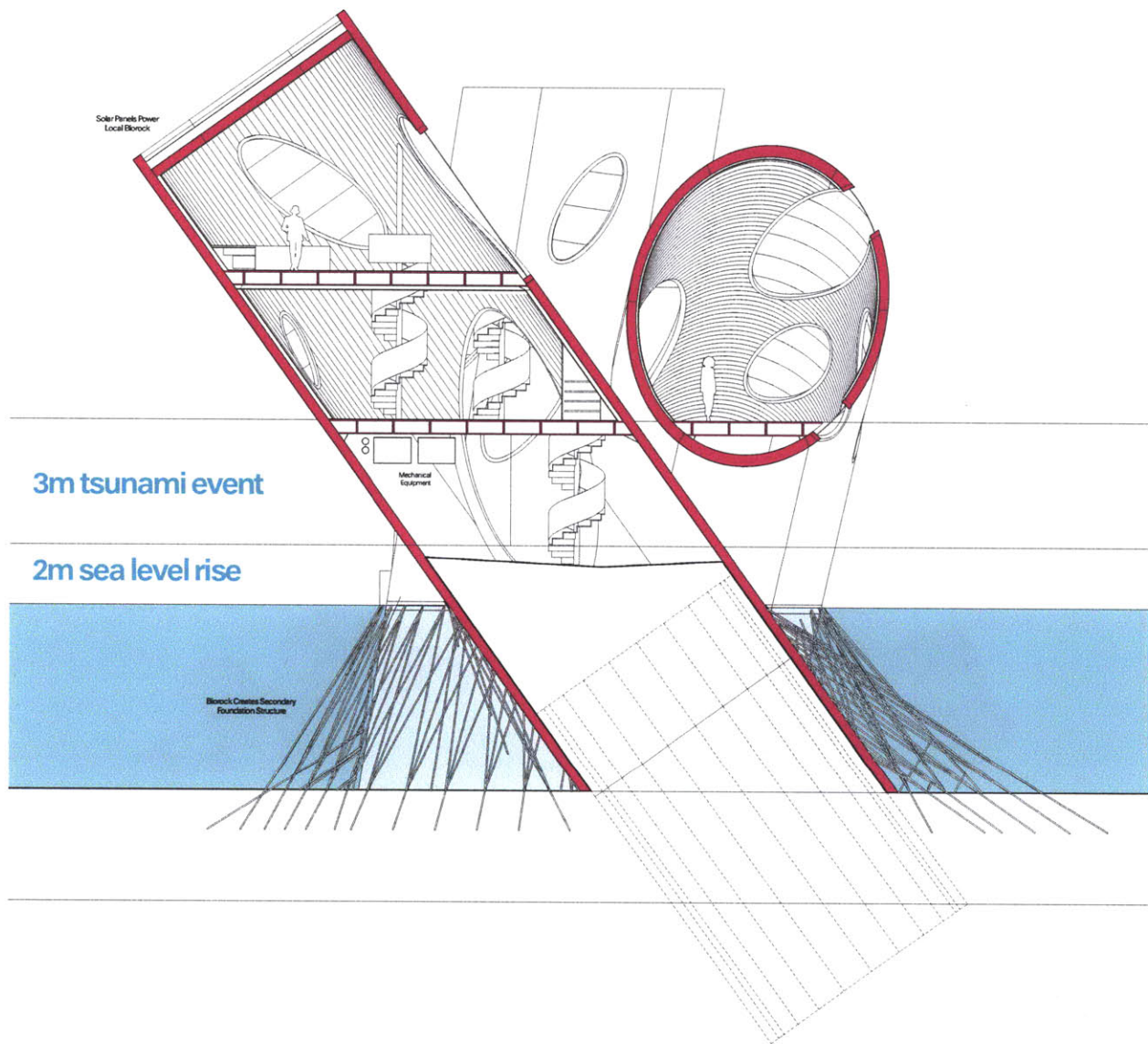
The Breakwater Bungalow is a guest unit designed to occupy peripheral artificial reef defenses. The units are shaped as tubes to break water coming from many different directions throughout the year, but are bundled for stability and angled to produce both communal and isolated spatial conditions. The Breakwater Bungalow is the ultimate in durable architectures, allowing the tourist industry to push further out into positions otherwise thought too vulnerable for development. When grouped together and coupled with artificial reefs, this strategy can create a halo of coral around an island that will scatter wave action and increase biodiversity. These reefs will also produce sediment, which can be captured on shore using groynes and redeposited to raise critical portions of the island.



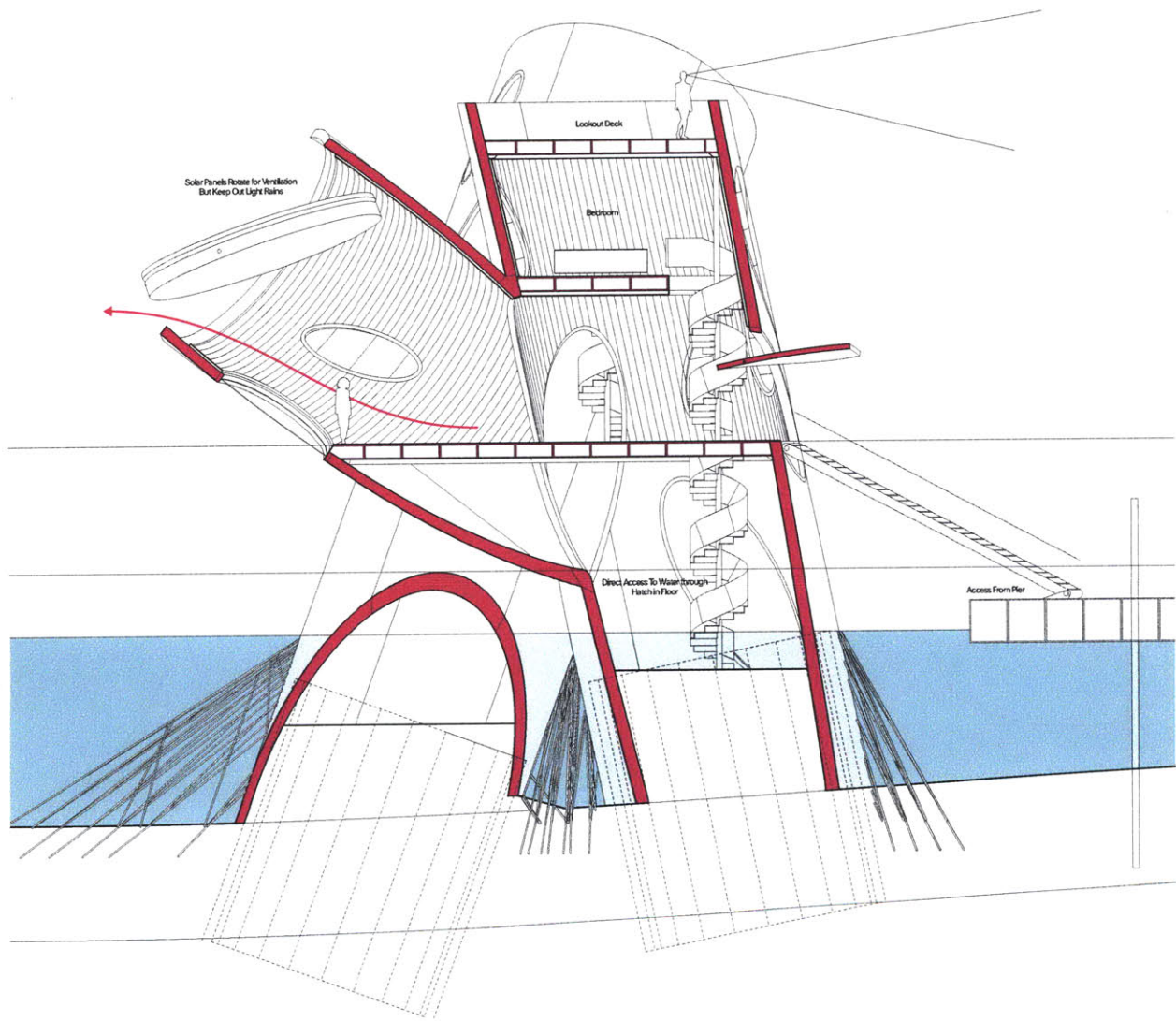
Field Condition: Access By Boat



Line Condition: Extension of Piers, Access by Jetty

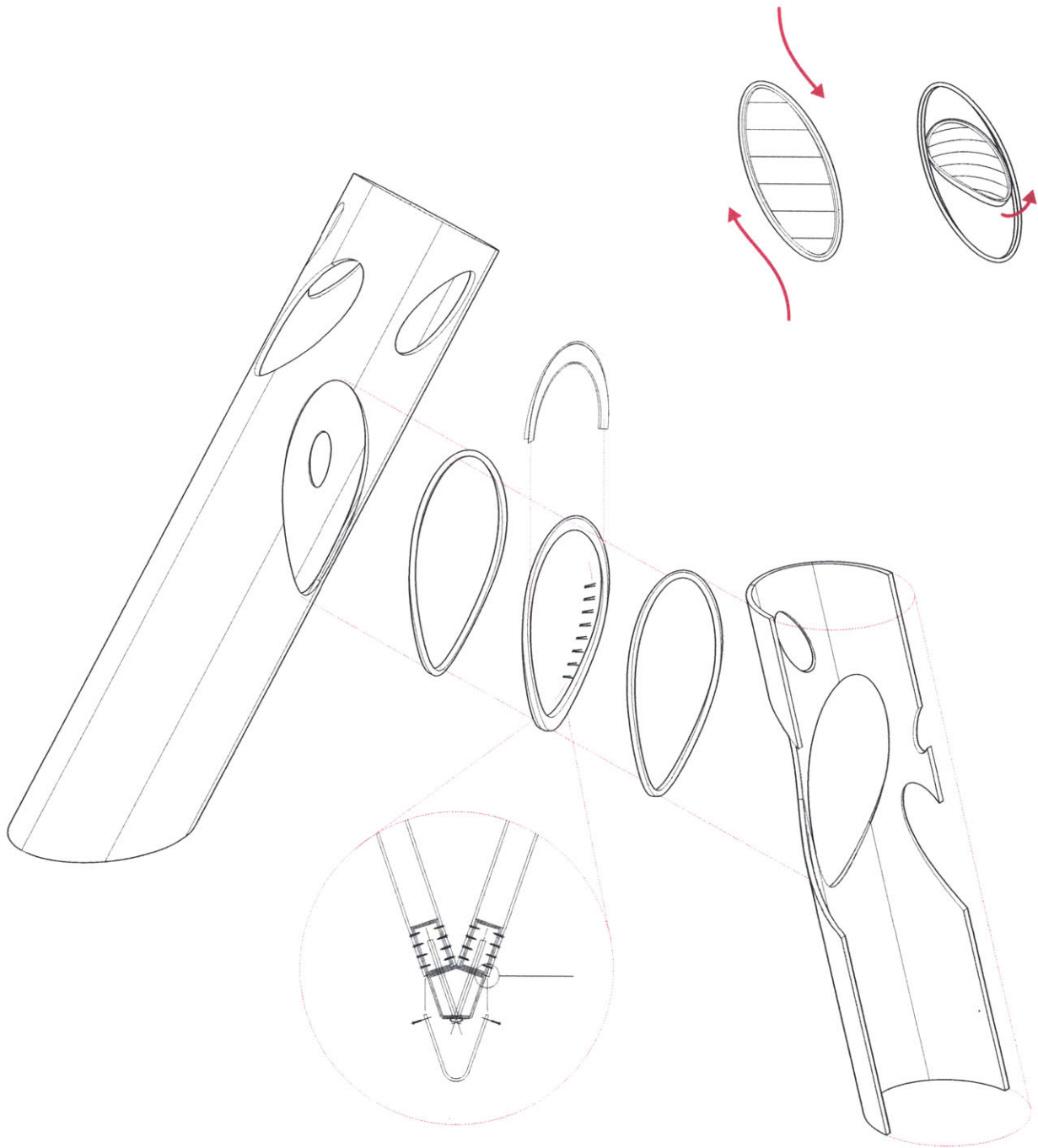


As seen in this section, the splayed arrangement of tubes produces discrete spatial conditions while providing a stable tripod base. Primary living space is on the upper two levels, but the bottom zone (within the 5 meter flood zone) can be used for bathing and storage of recreational equipment.

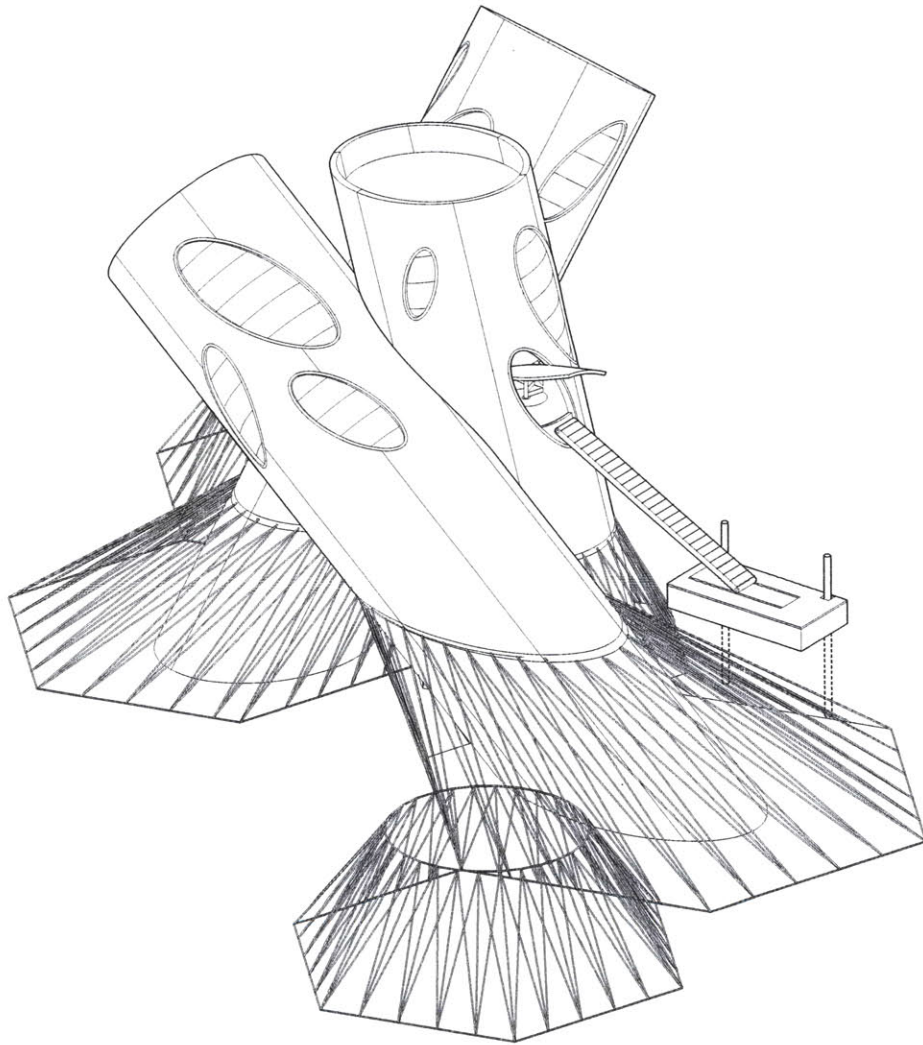


Before installation of the tubes, circular sheet pilings are driven into the reef as footings. Each tube is then bolted onto this foundation and bundled with the structural collar. In some cases, such as the living room, a solar panel encrusted roof cap can rotate open, further opening the building spatially and facilitating natural light and ventilation.

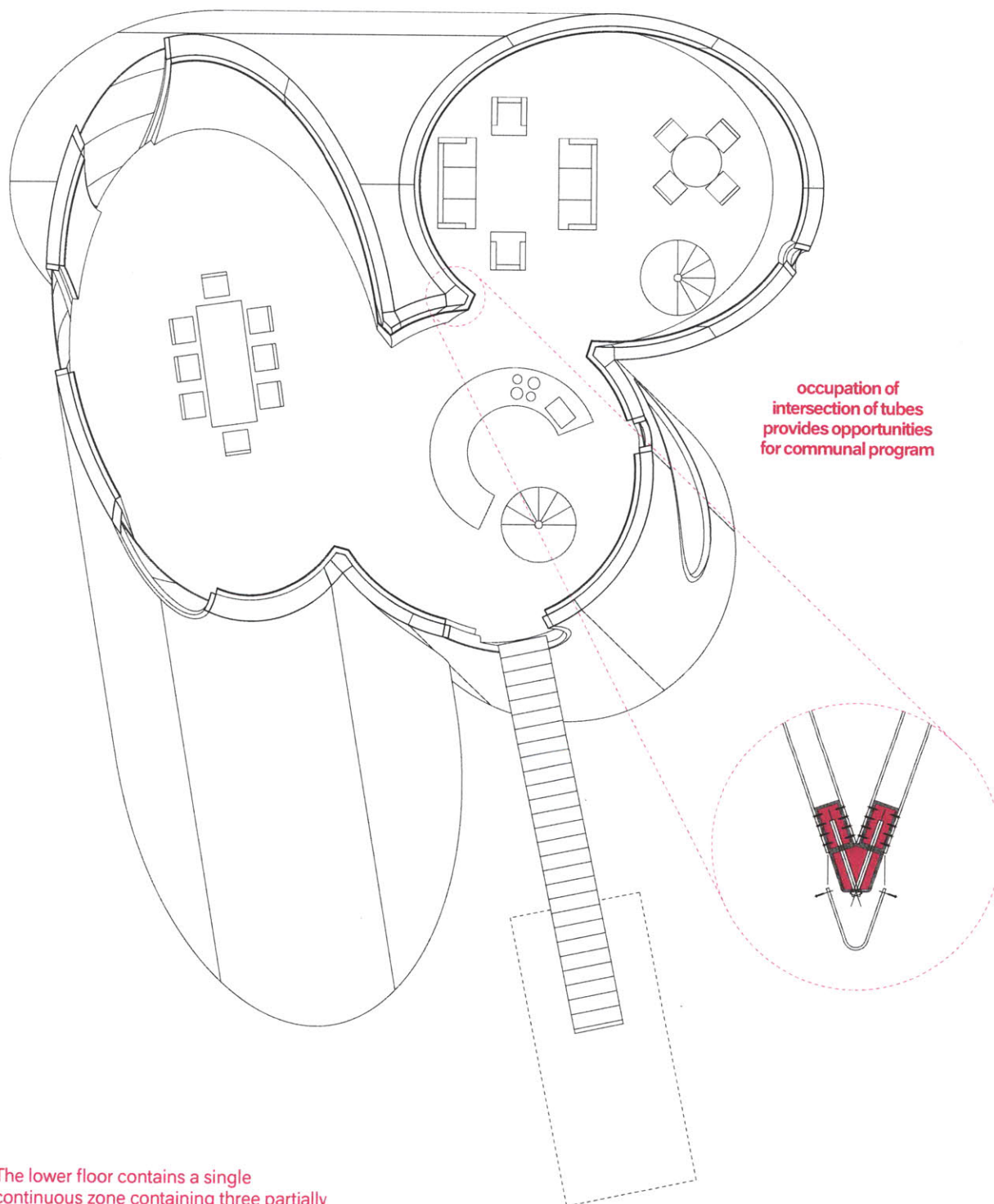




A structural collar of composite material or steel secures tubes together on site. Pockets for the collar are milled into the panels during the fabrication process to allow for variable configurations. Round windows are used to produce a continuous waterproof seal, and are the best form to allow stresses to move through the skin without cracking the panels at the apertures.

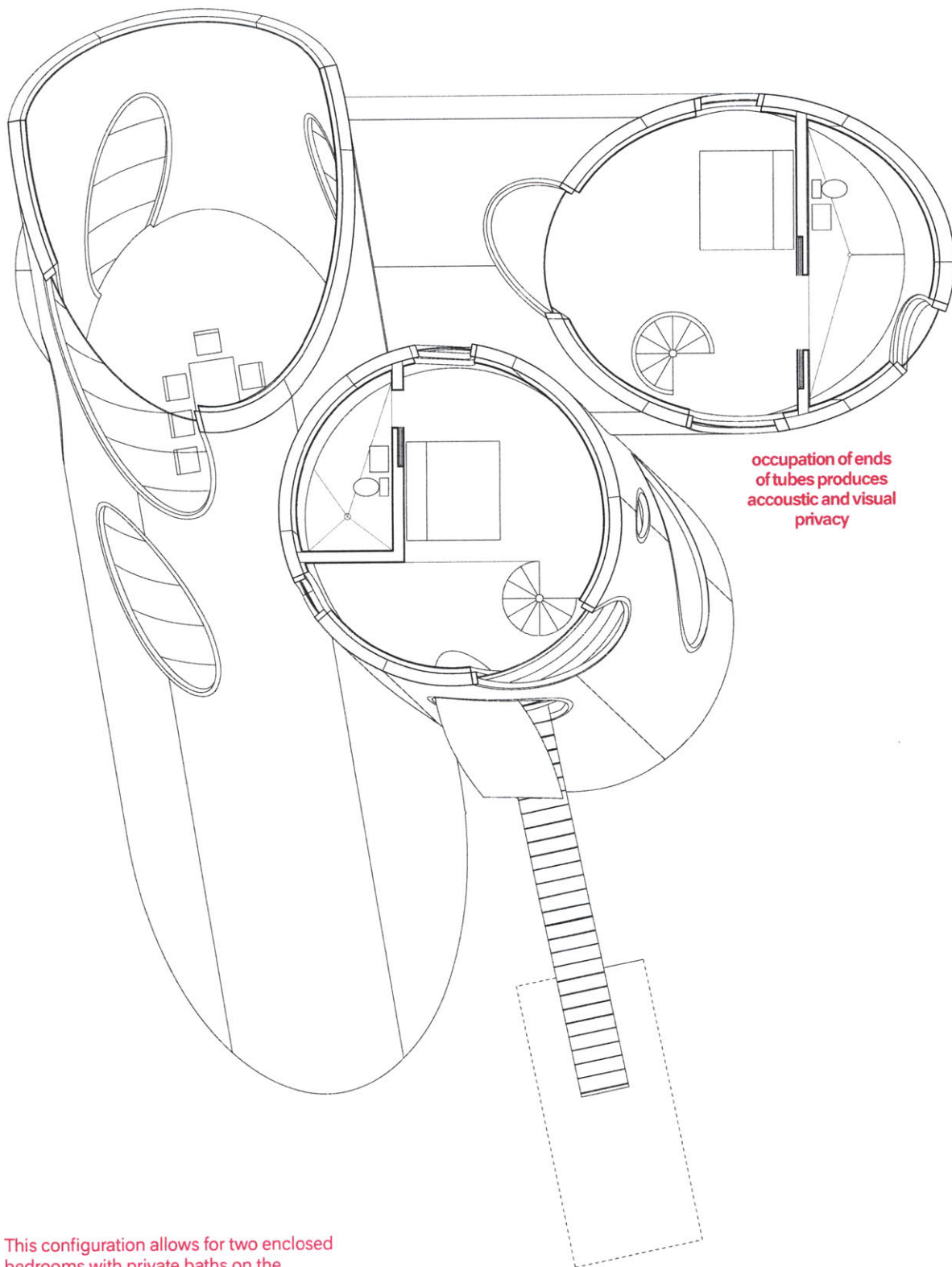


The base of each tube is wrapped with a steel foot which is attached to the solar panel on the roof to produce artificial corals. In addition to increasing biodiversity, the feet create a foundation that will grow more robust over time, and permits the building to participate in the defense of the island.

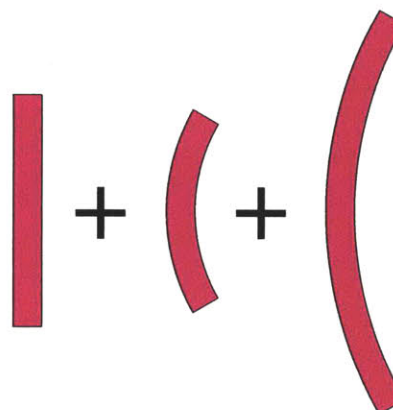
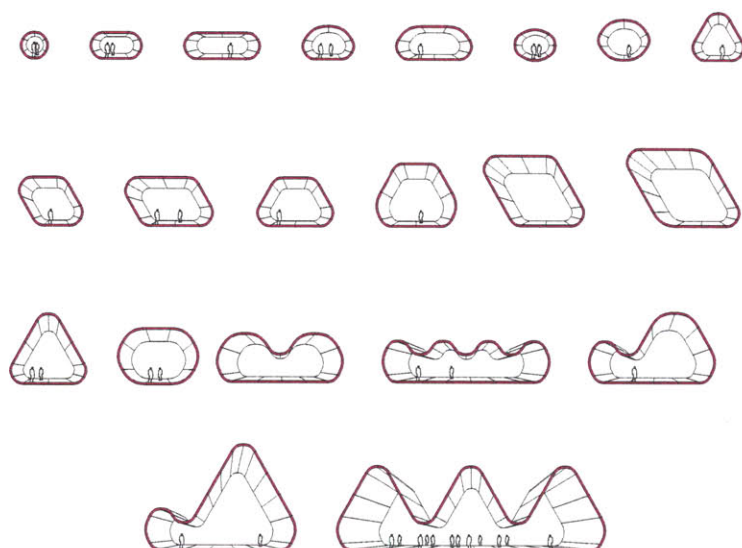
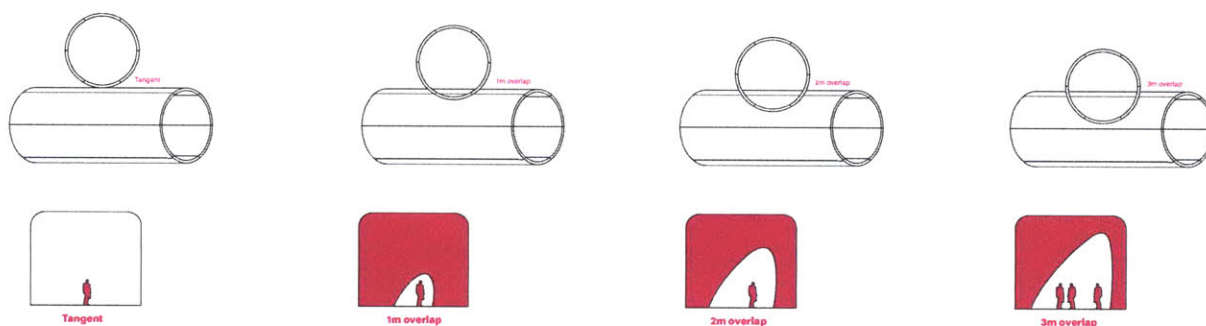
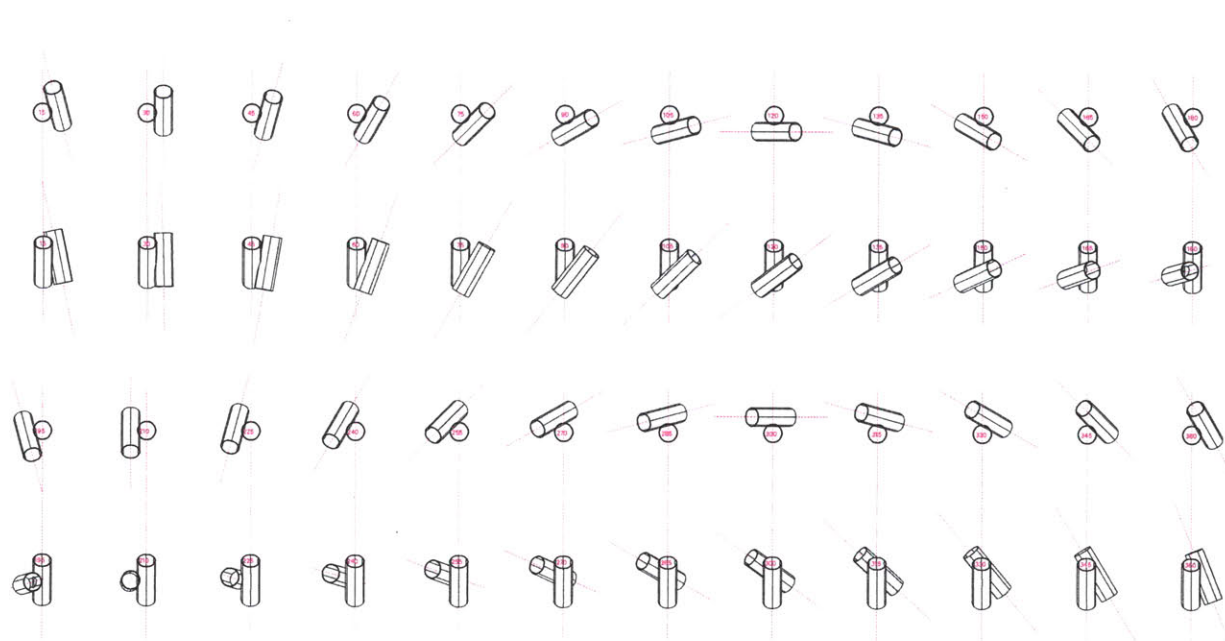


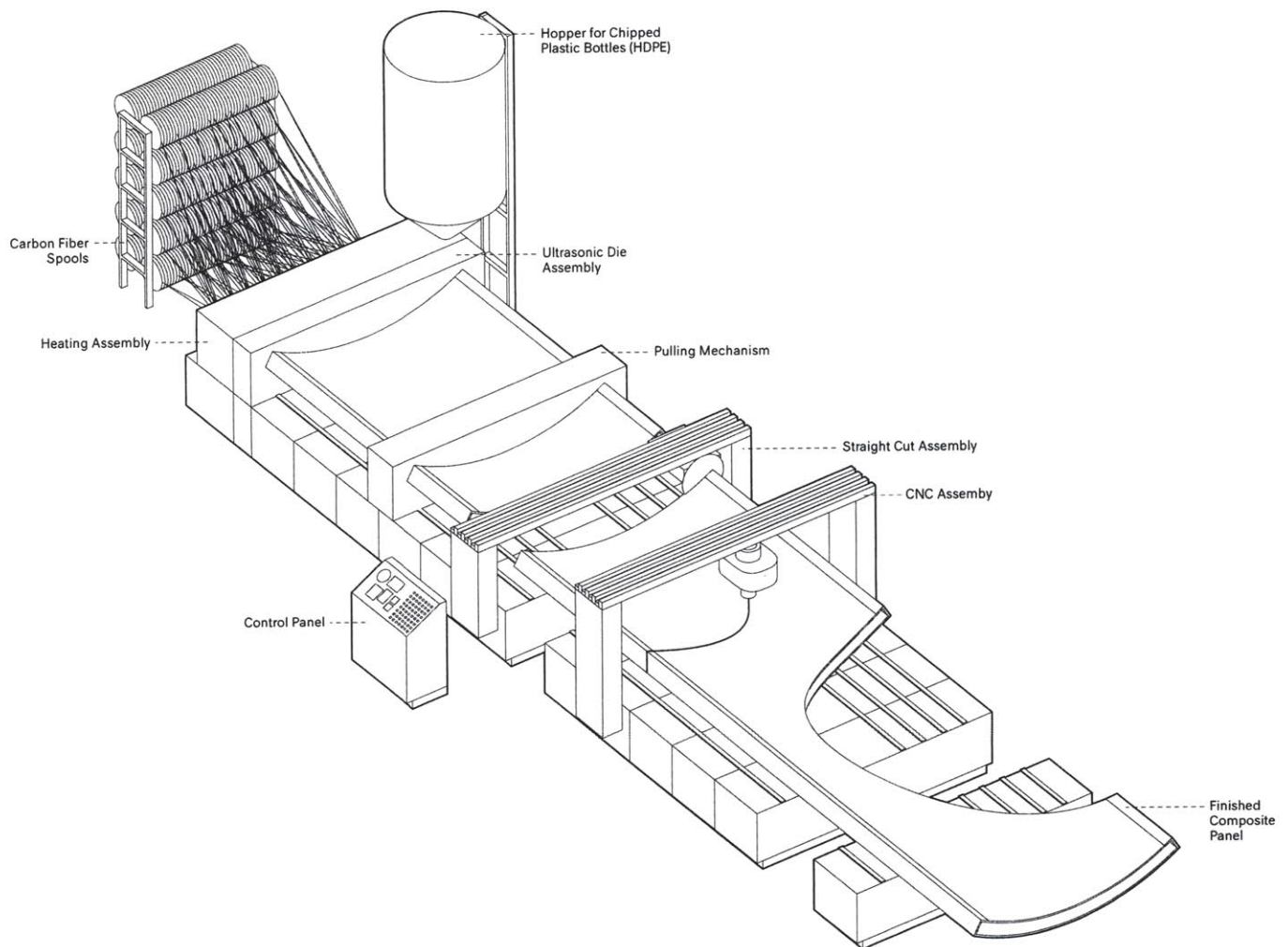
The lower floor contains a single continuous zone containing three partially distinct rooms: kitchen, lounge, and dining room. Access is achieved through the kitchen by floating gangway.





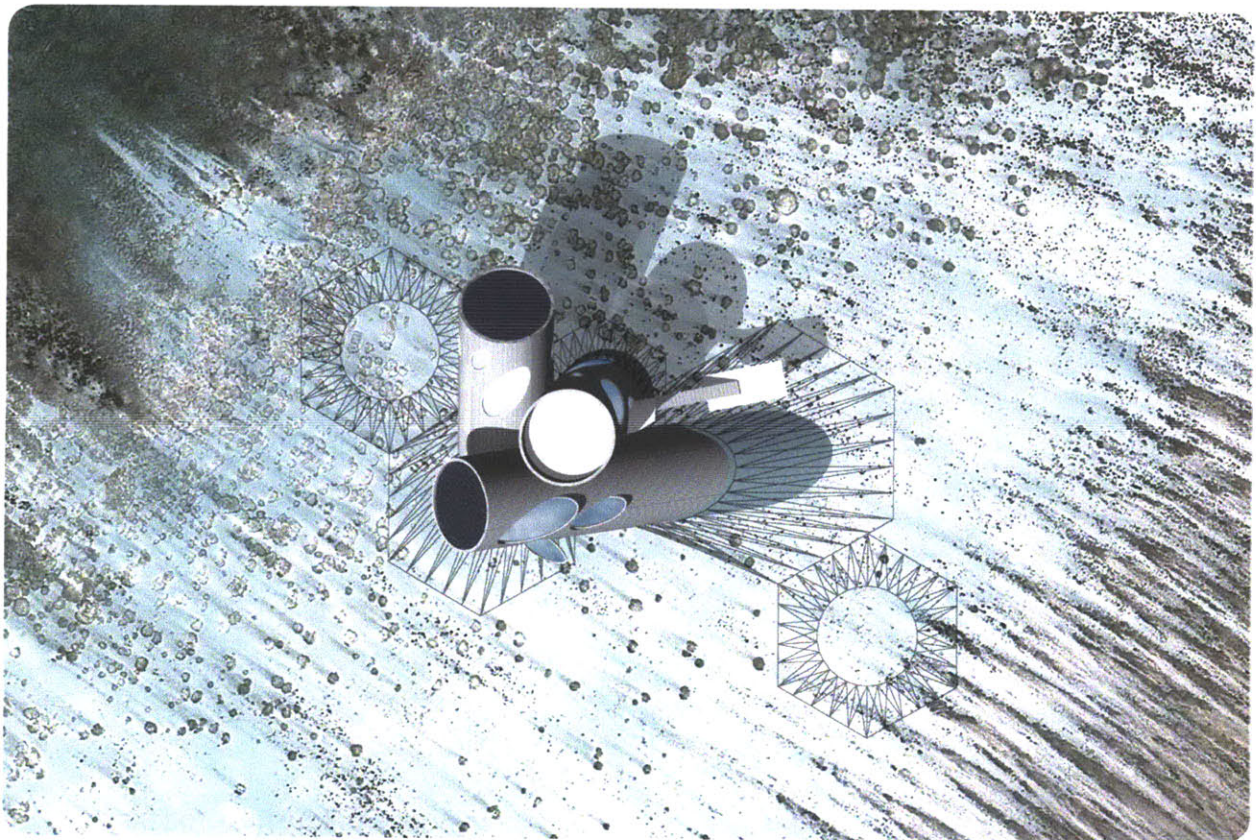
This configuration allows for two enclosed bedrooms with private baths on the upper floors, while the dining space is double height to act as a passive thermal chimney.





- ▲ The primary building panels are constructed through a continuous pultrusion process. Recycled plastics are fed from a hopper through an infrared heating device, at which point the plastic impregnates carbon fiber or fiber glass strands to produce structural units of variable length. Within the same assembly process, a 5-axis router excavates apertures for windows and doors, and places holes for anchors between panels.
- ◀ An array of three panel types produces an array of base sections to produce variety between housing units or larger elements which serve as the base units for restaurants, bars, and spas. Each completed building unit is designed with specific intersections that correspond to a set of structural collars (see later exploded axonometric). The depth at which two volumes intersect determine the size of the opening, producing a range of enclosed or connected spaces. In the case of the Breakwater Bungalow, each volume rotates around the others centroid, producing the ability to carefully calibrate each instance to site conditions while still maintaining modularity.



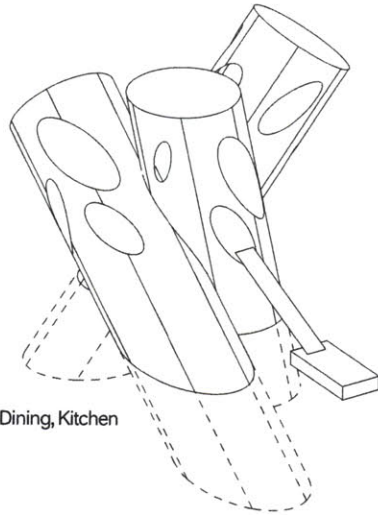


After several years, the artificial reef foundations of the breakwater units no longer require an electrical current, and will have flourished into fully self sustaining reef systems.

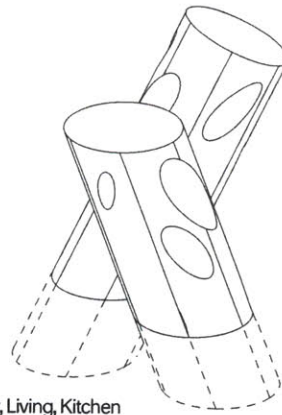




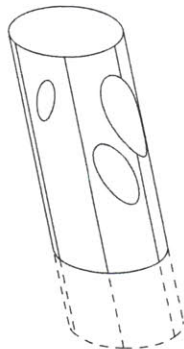
# Bungalow Types



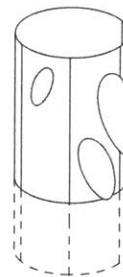
2br, Living, Dining, Kitchen



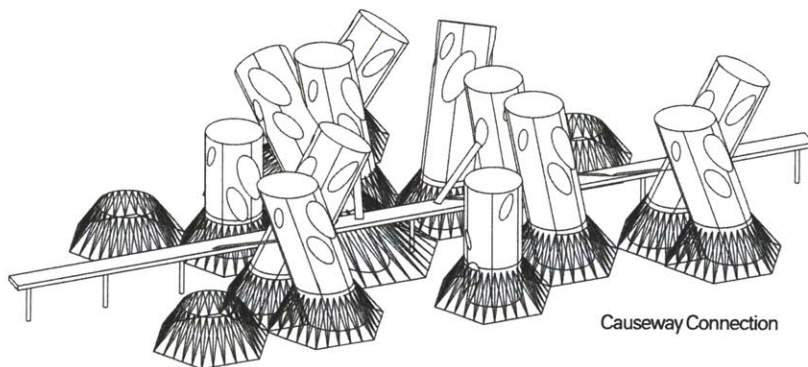
1br, Living, Kitchen



1br, Living



1br

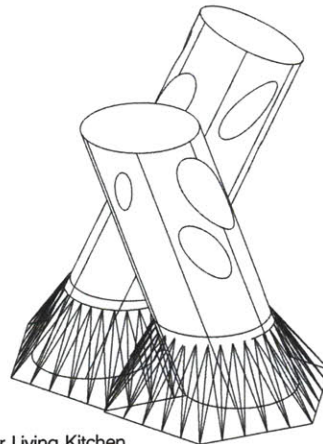


Causeway Connection

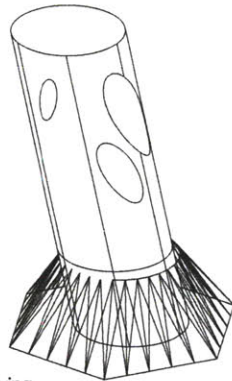




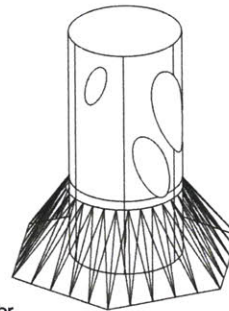
2br, Living, Dining, Kitchen  
w/Reef Foundation



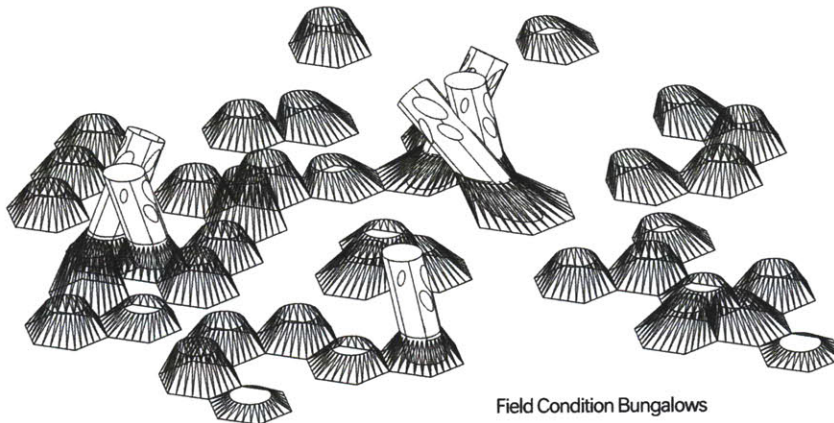
1br, Living, Kitchen  
w/Reef Foundation



1br, Living  
w/Reef Foundation



1br  
w/Reef Foundation



Field Condition Bungalows

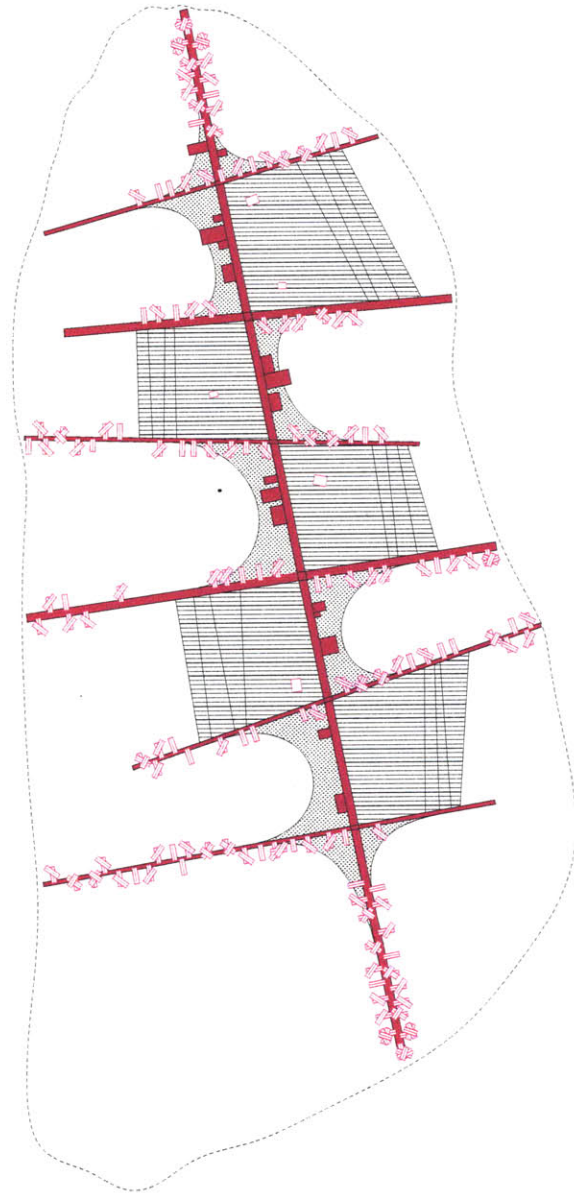




# Wet/Dry Villa

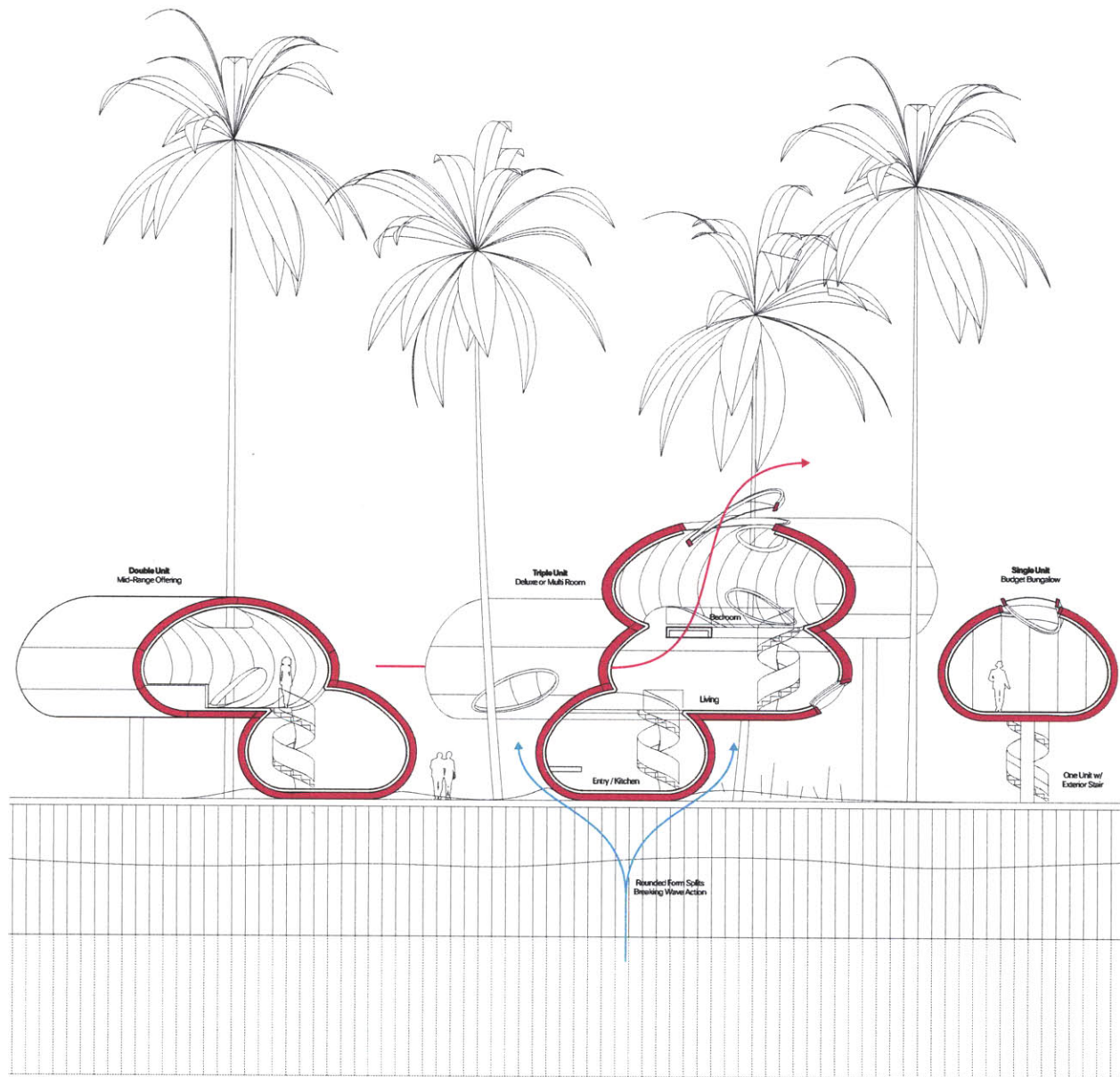
The Wet/Dry Villa is constructed using the same process as the composite panels in the Breakwater Bungalow, but is deployed in a horizontal position to facilitate its attachment to seawalls. The structural envelope allows the villa to cantilever from walls intended to shore up agricultural land and populated areas. Each villa is made up of one or more components, depending on accommodation requirements and amenity type. Individual building units can be assembled on Thilafushi, transported by barge or helicopter, and bolted together on site. Seams are then welded thermally to make the structure water tight. The rounded forms cause waves to refract up and around the units, dissipating energy into space rather than reflected against the structure itself. The extreme durability of these villas allows for the occupation of breakwaters and sea walls that would be otherwise too exposed to wave action, both increasing the total occupiable space of resorts, but also producing a new typology of housing type that gains value through its position in sublime environments.

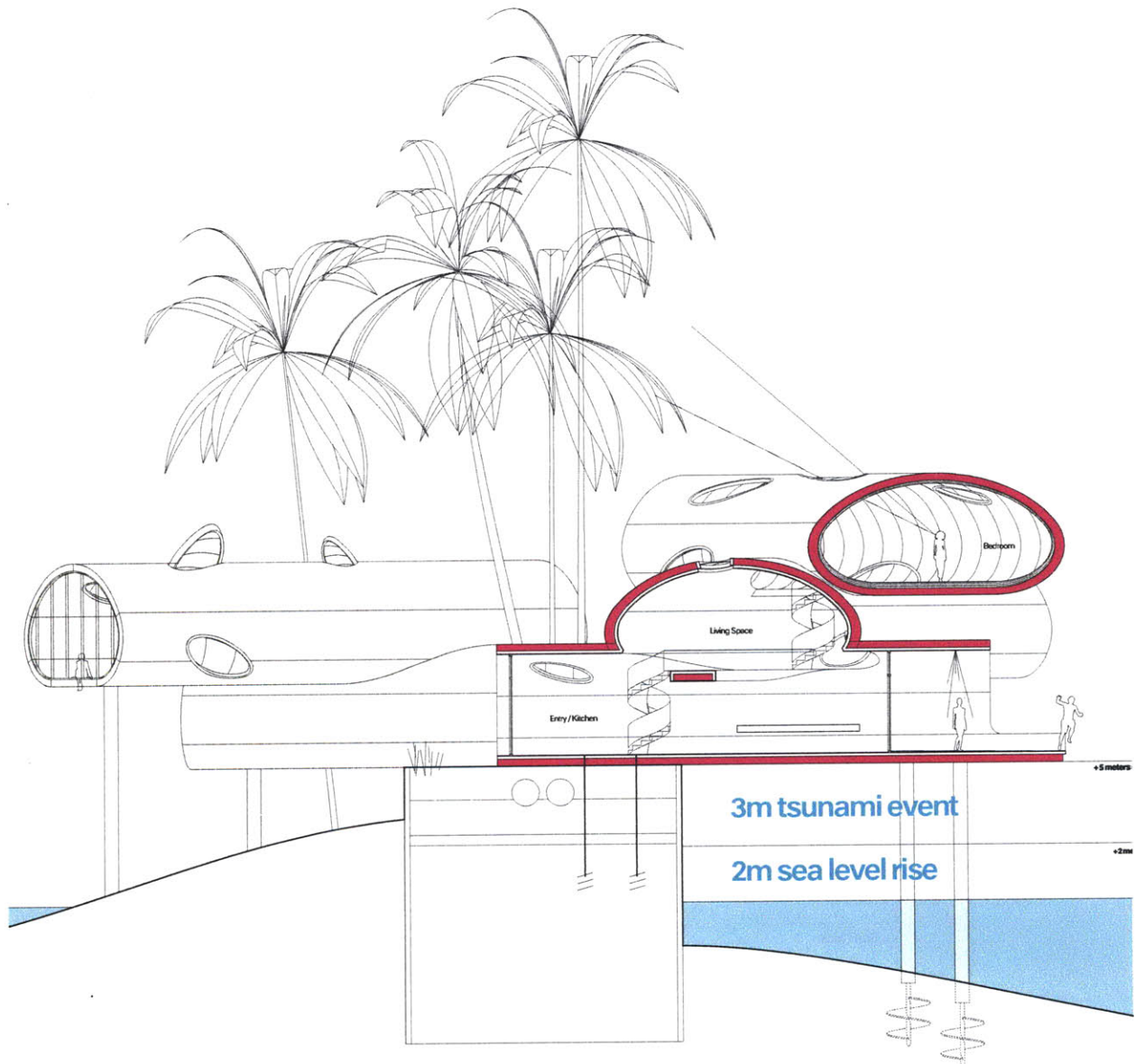
The villa is also designed to occupy edge conditions, allowing shored up agricultural parcels to be used as resorts without compromising their capacity to produce food. At right, the farm island of Maamalgili is shown with 200 units deployed along composite sea walls that follow existing roads. A central spine accommodates larger functions such as spas, dining, and support facilities.

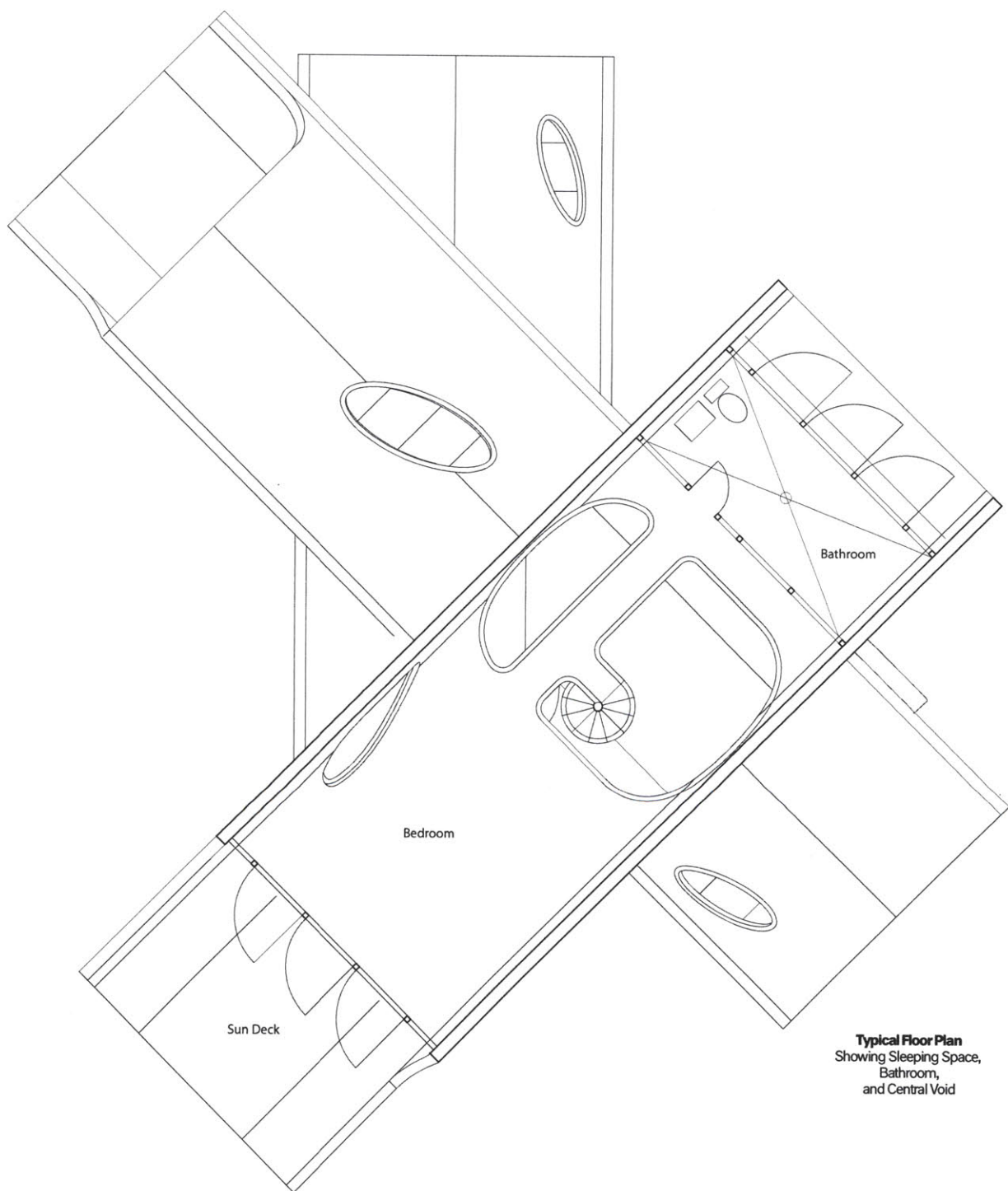


**Soneva Gili Configuration: 200 rooms**  
Agri-Tourism

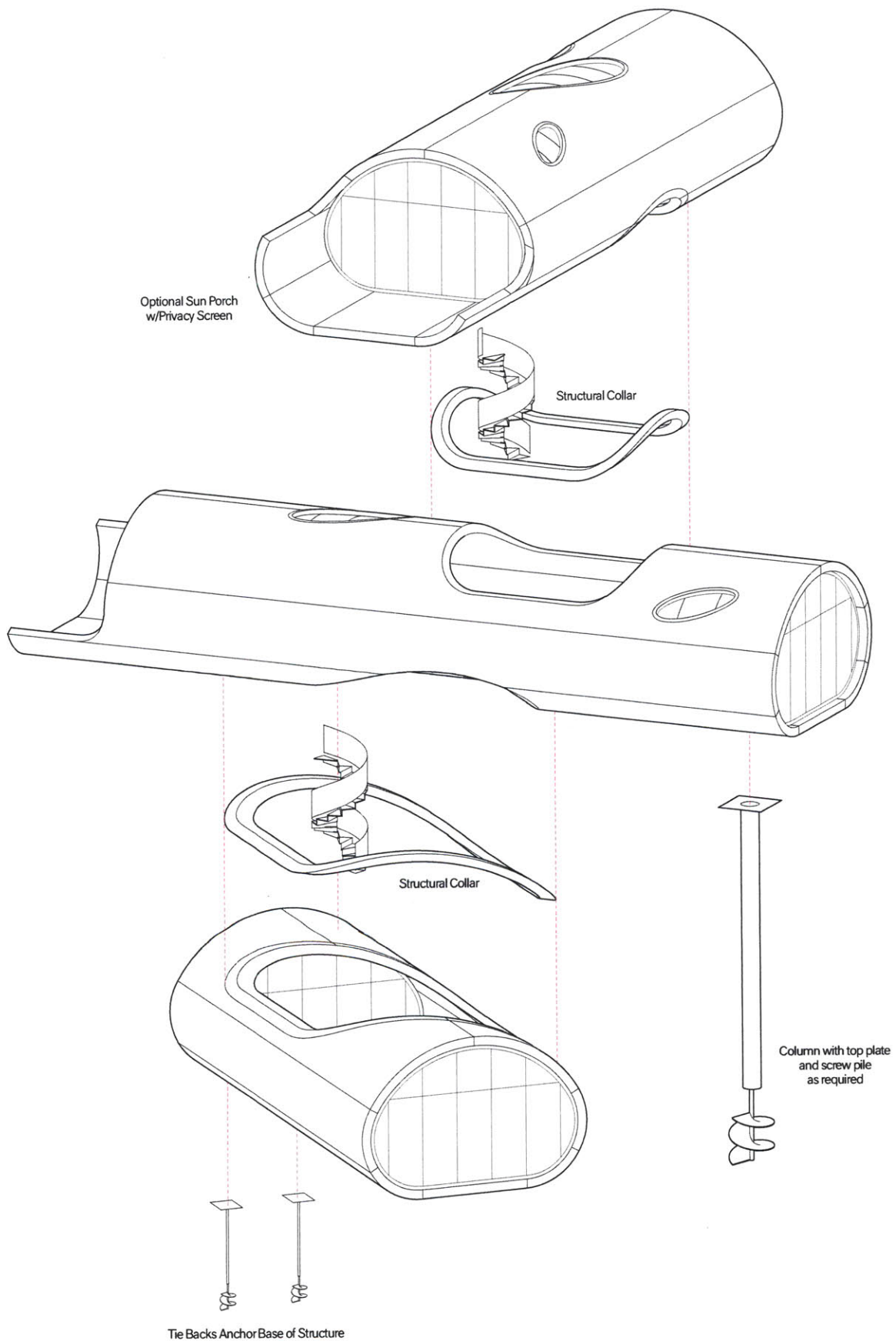


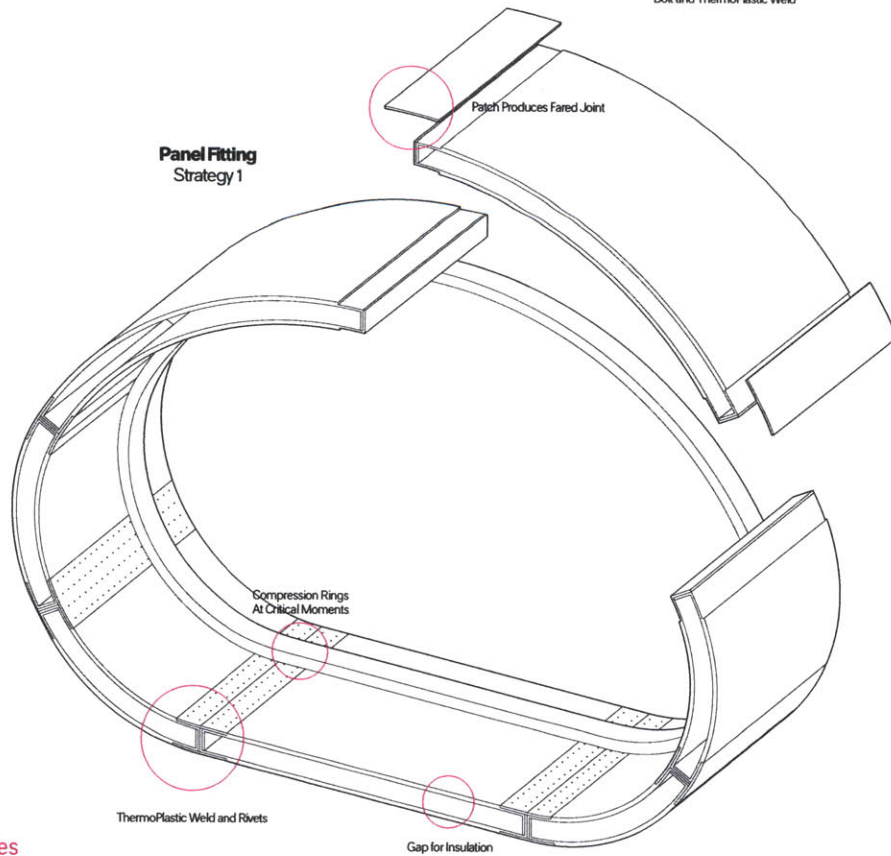
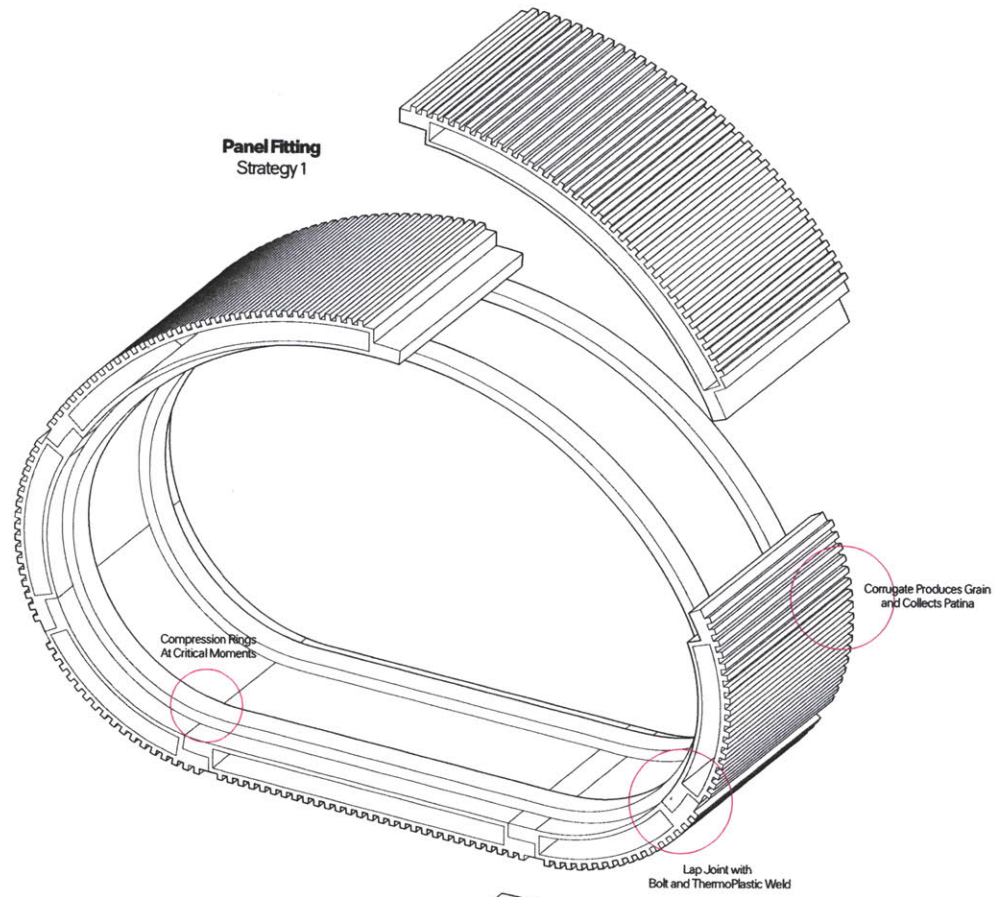




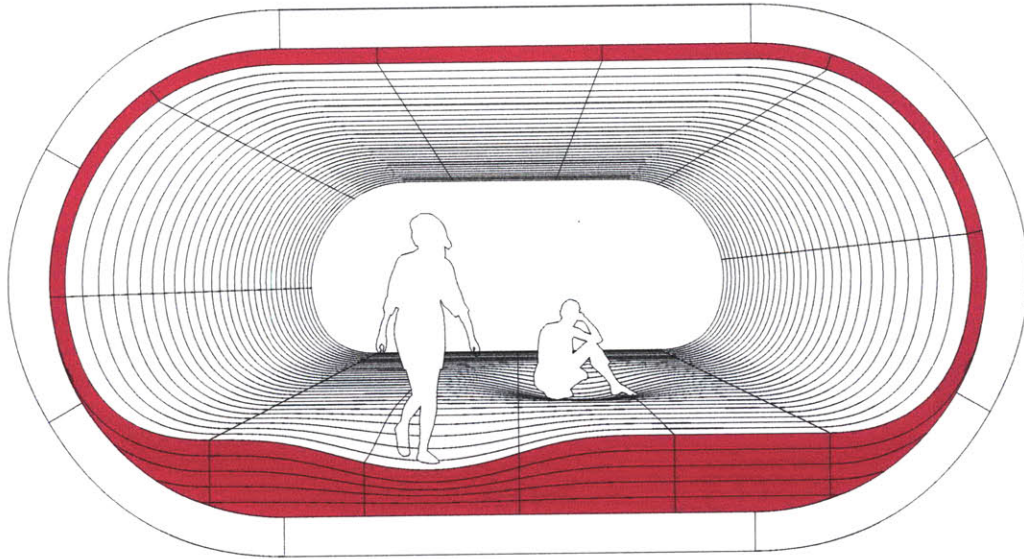




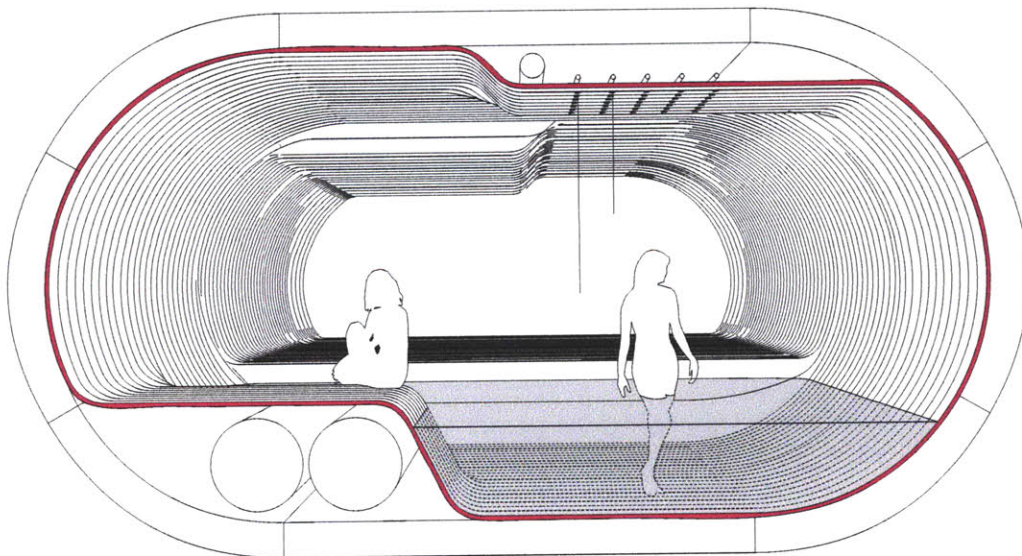




## Assembly strategies

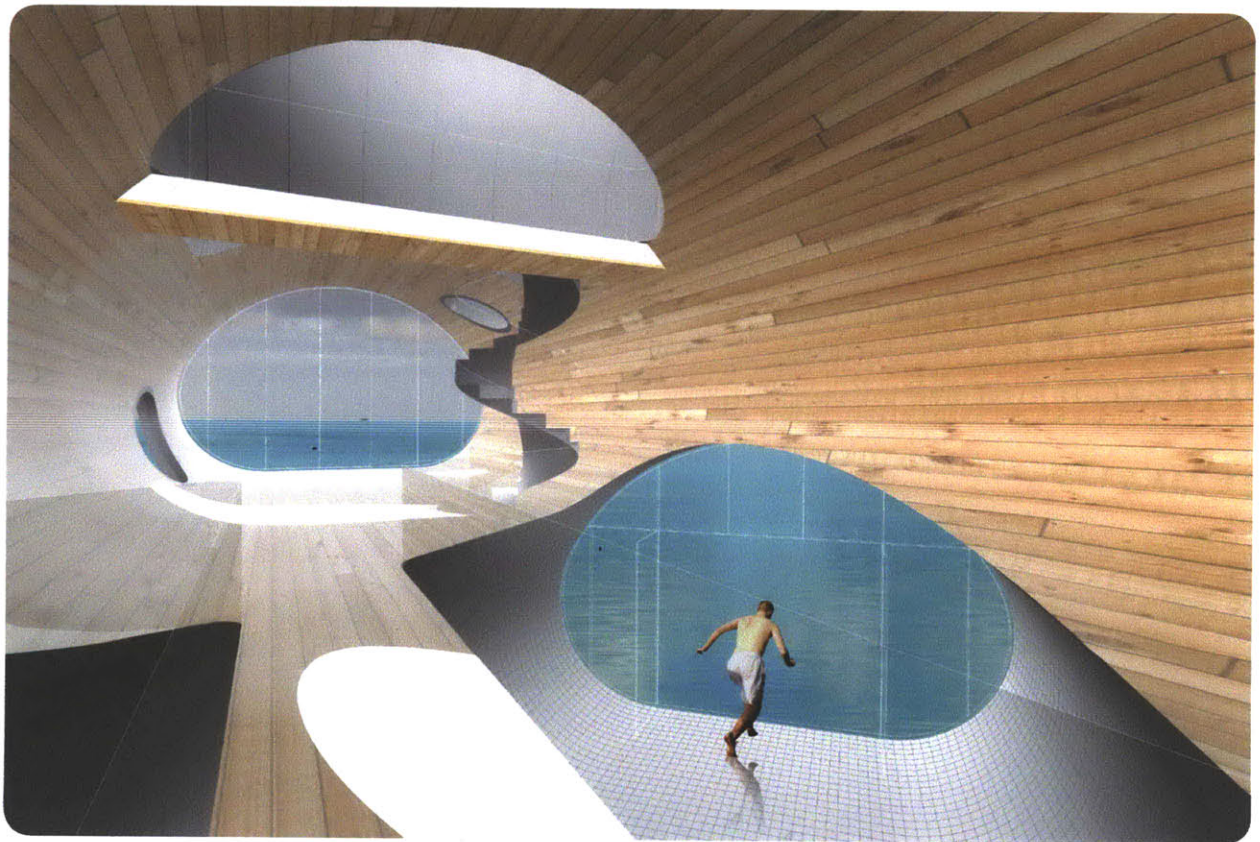


Soft space for lounging and sleeping

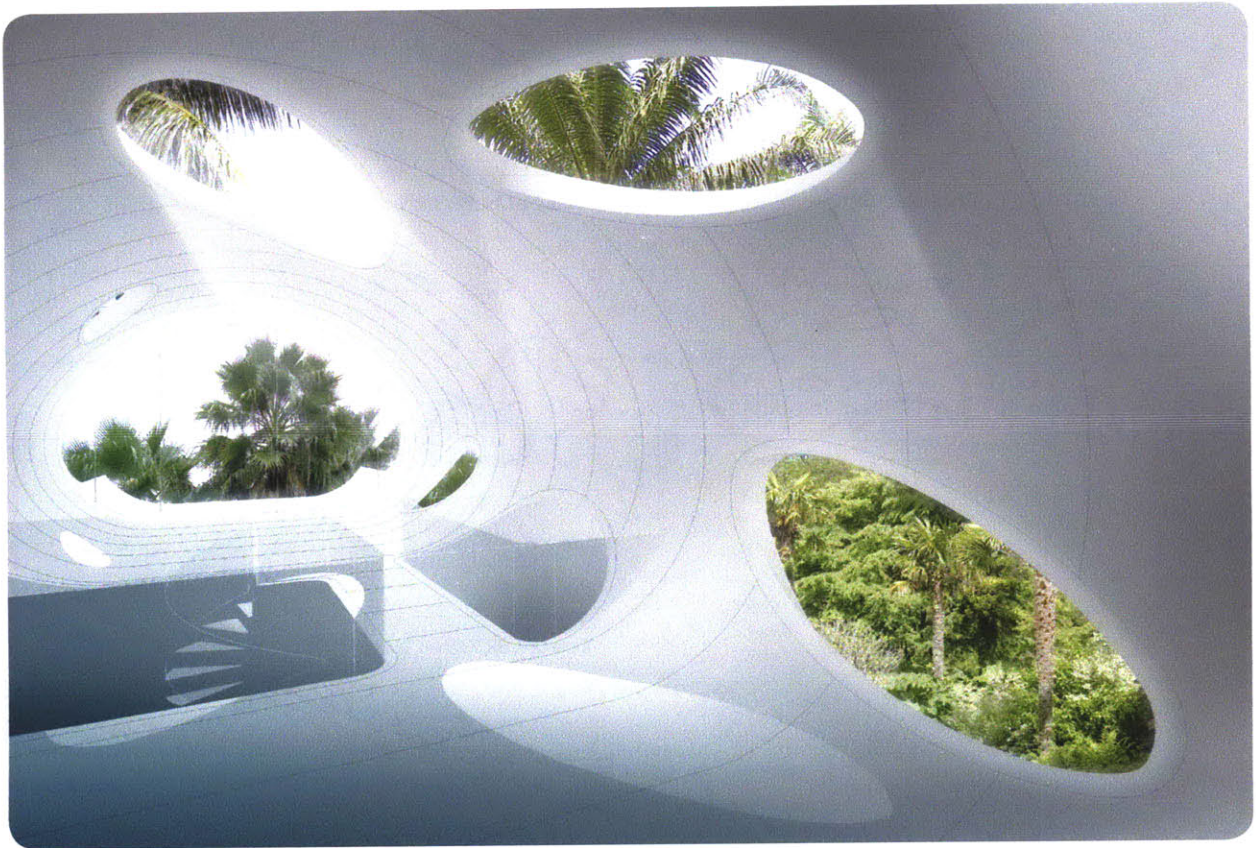


Wet space for bathing and relaxation



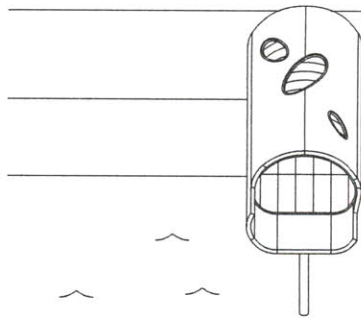


Interior skins define the programmatic capacity of each building volume: tiles allow the lower kitchen unit to be used as a bath and shower, with direct access to open water or the beach. The zone can be easily hosed out. The wooden zone is used for dining and relaxing. On the facing page, the upper bedroom is padded, turning the walls and floor of the entire room into a giving surface for sleeping and lounging.

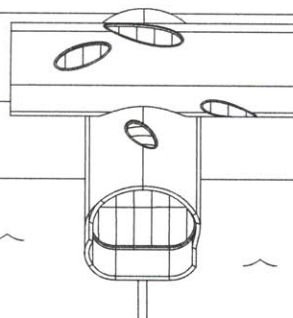




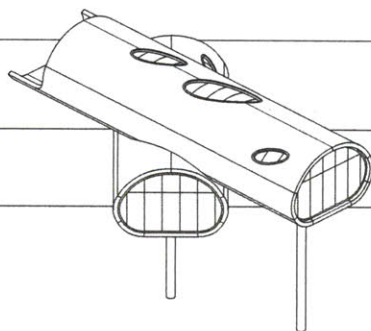
# Villa Types



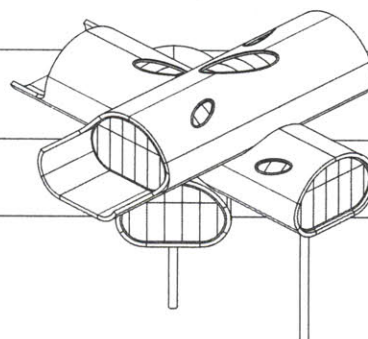
Single Unit: 1 BR



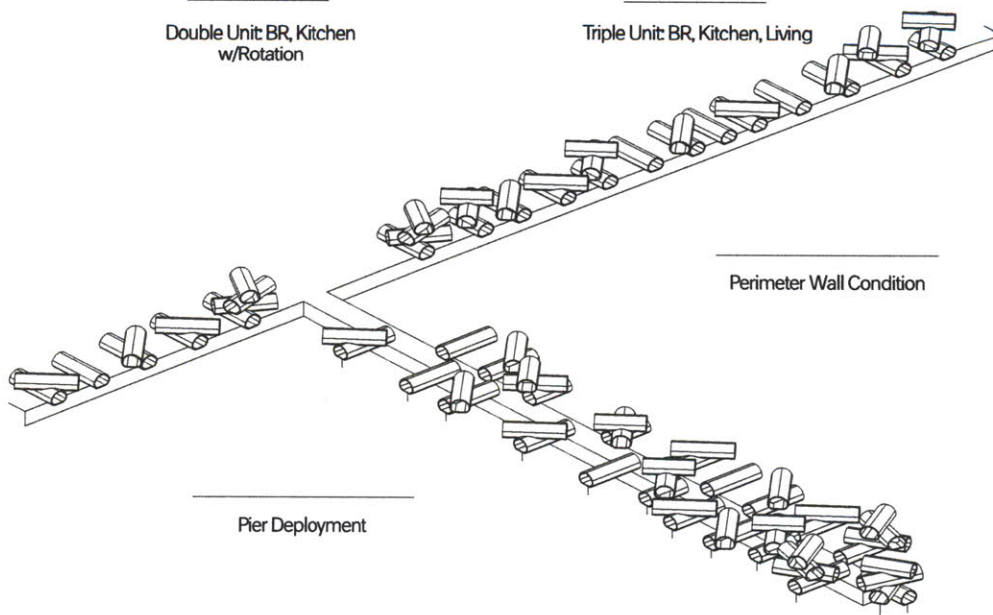
Double Unit: BR, Kitchen



Double Unit: BR, Kitchen  
w/Rotation



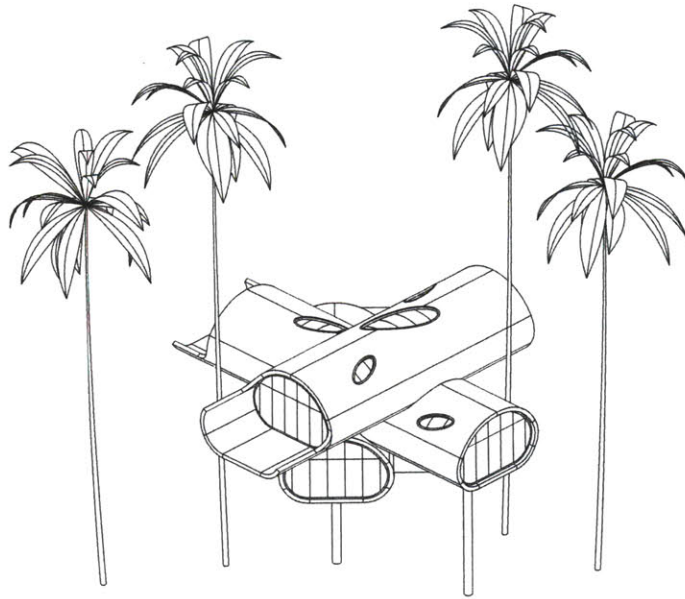
Triple Unit: BR, Kitchen, Living



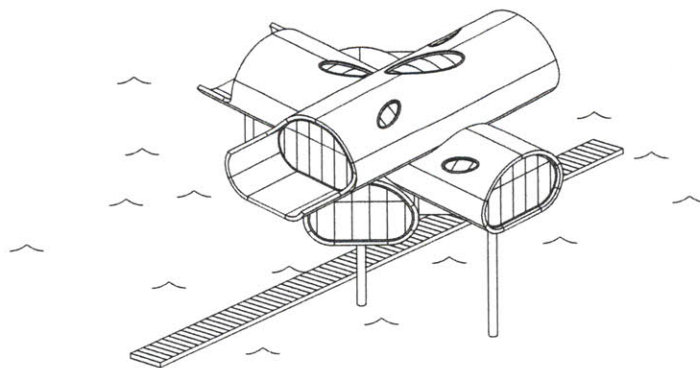
Perimeter Wall Condition

Pier Deployment





Palm Farm Condition



Stand Alone Shallow Water

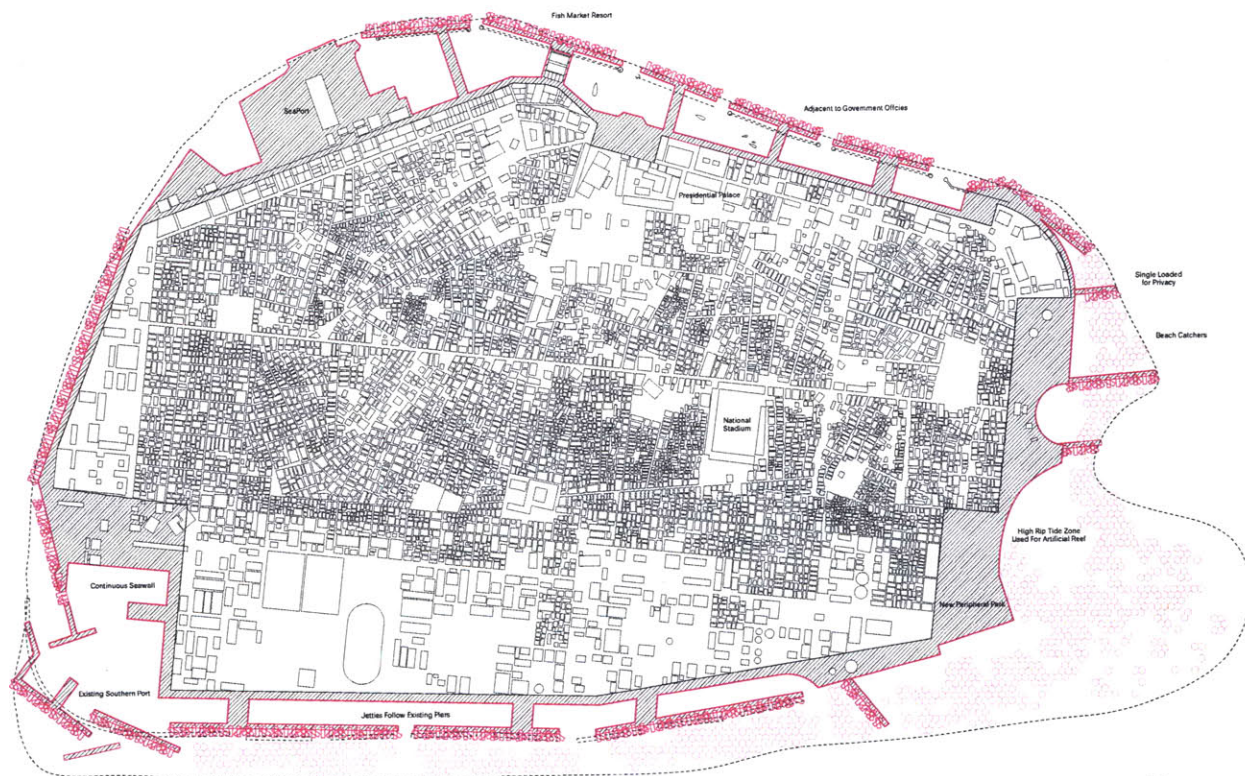


Male' 2010



Male' with 1 meter rise in sea levels





**Male' Configuration: 300-600 Villas**  
 1 Mega Resort Operator?  
 20 Smaller Resorts?  
 300-600 Independent Operators?

Although the capital city of Male' is one of the few islands in the Maldives that could afford to construct a defensive sea wall, this wall can become an economic asset with the deployment of tourist villas along the majority of its perimeter. With the exception of the commercial port and the public beach, over 600 luxury rooms can be added to the island, to be operated individually or ganged together into larger resort entities. The hatched grey portion above defines a perimeter park berm, made from reclaimed trash, both shoring up the composite sea walls and providing a continuous urban park for the city. The southern shore, the area most vulnerable to storm surges and tidal waves due to its adjacency to the open sea, is encircled with artificial reef development.





Final Villa Model





Final Bungalow Model

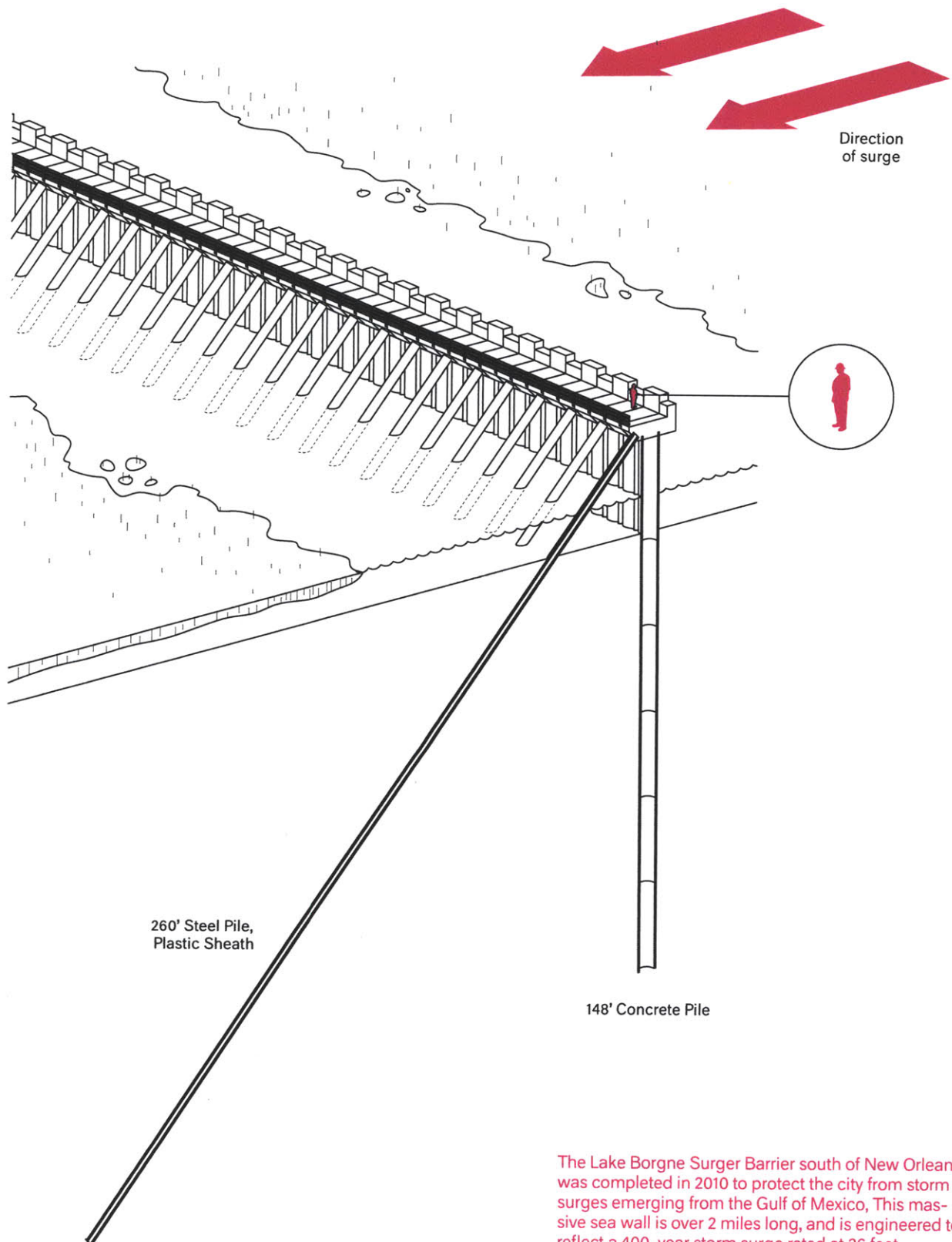


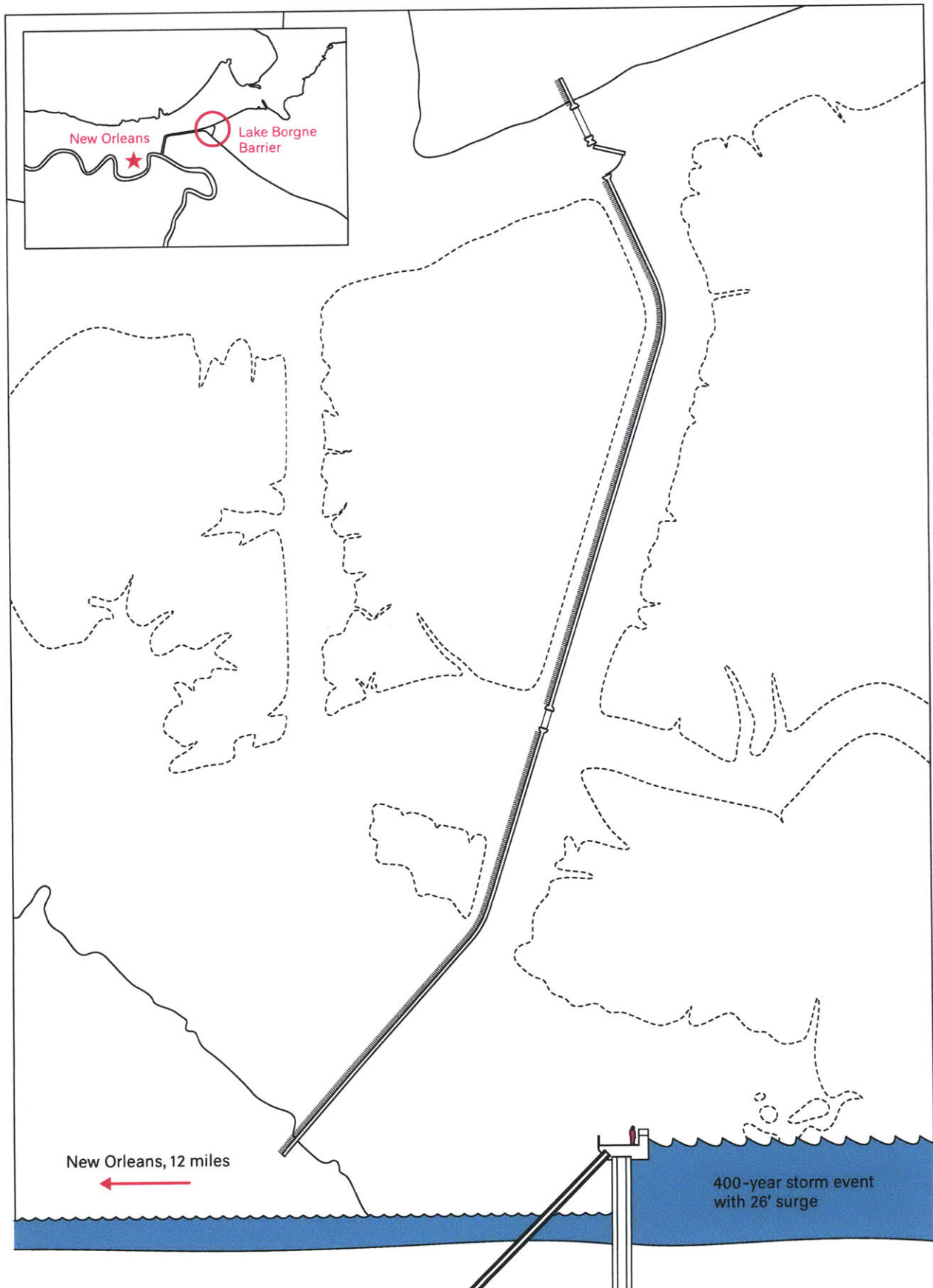


# Infrastructural Precedents



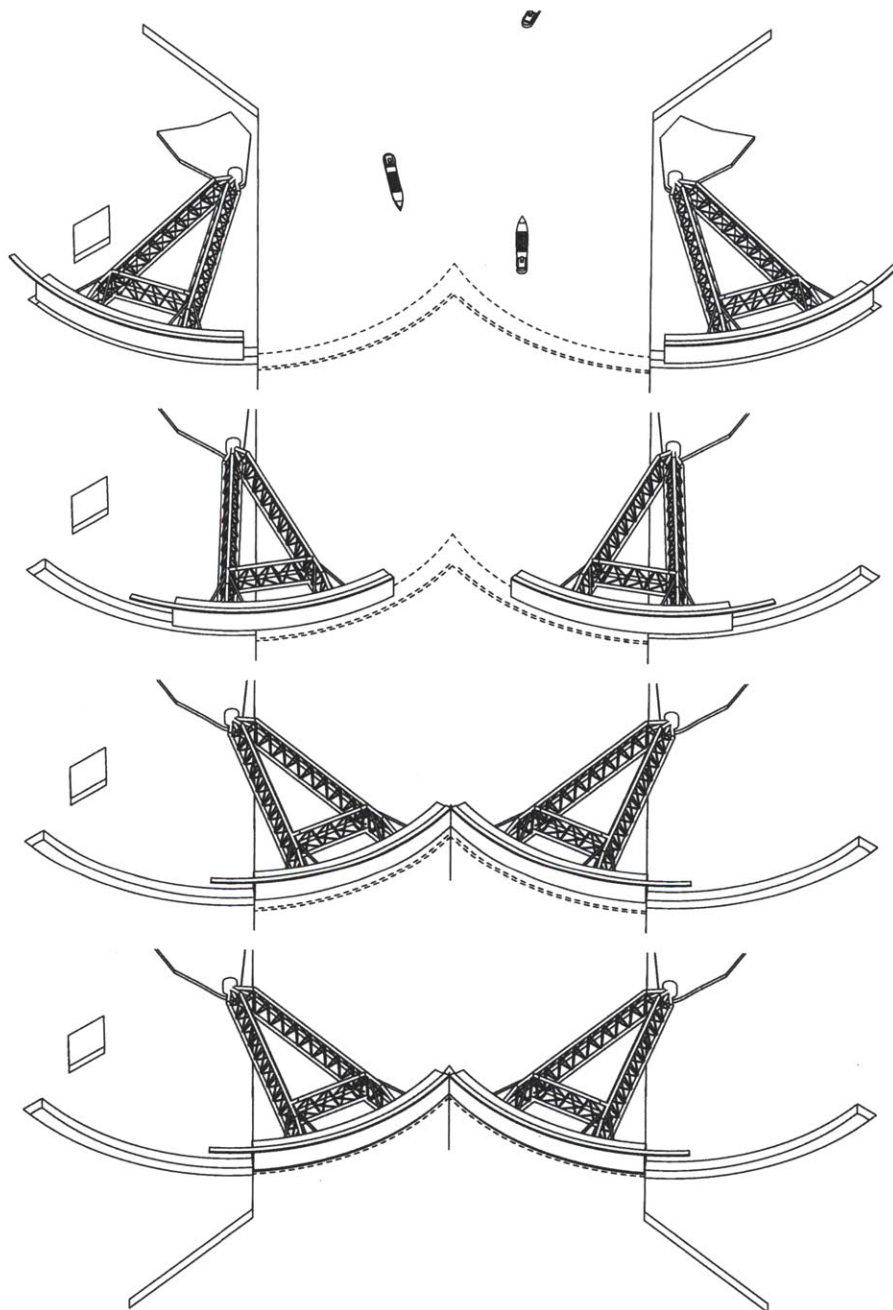
## Lake Borgne Surge Barrier New Orleans, USA

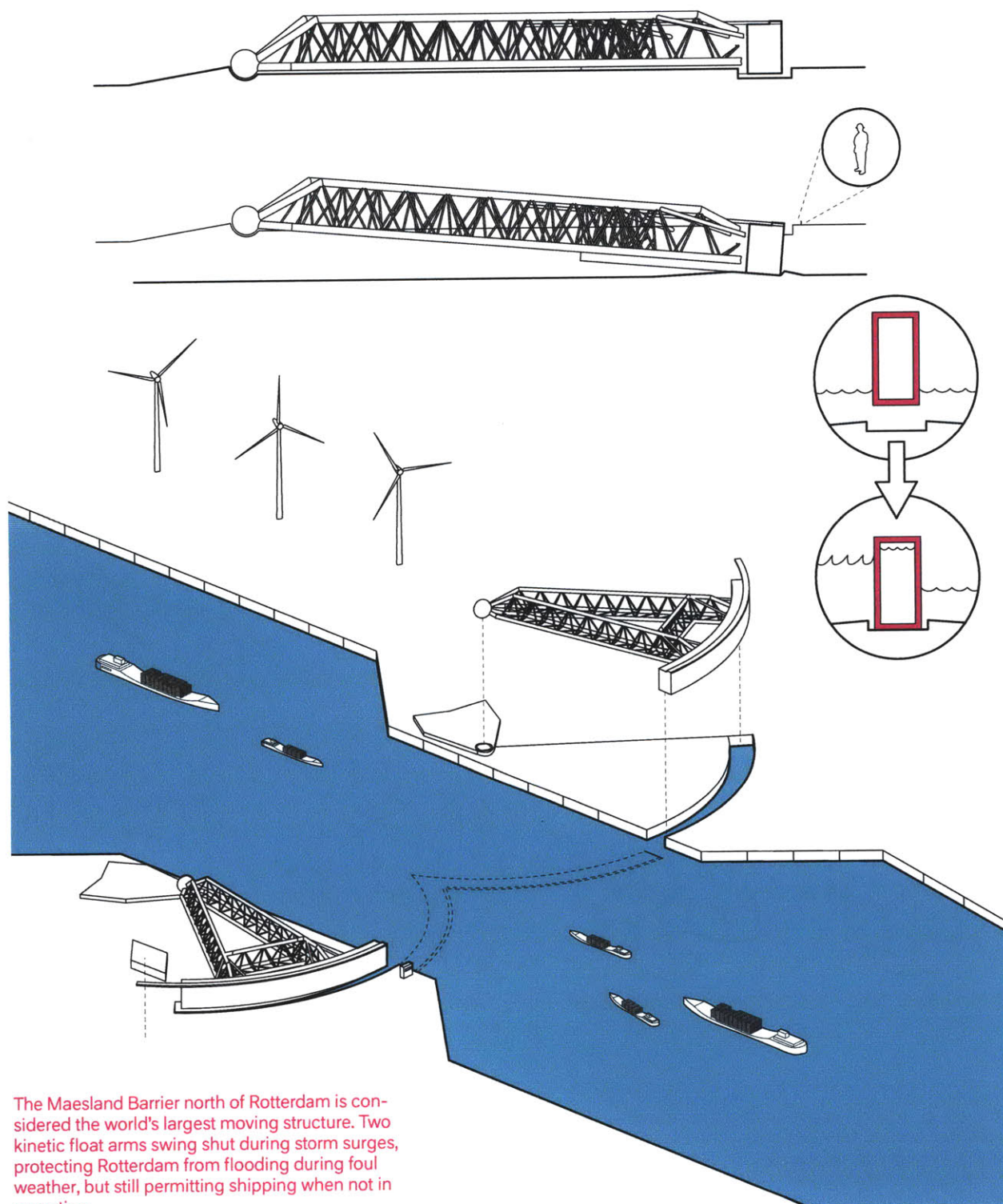






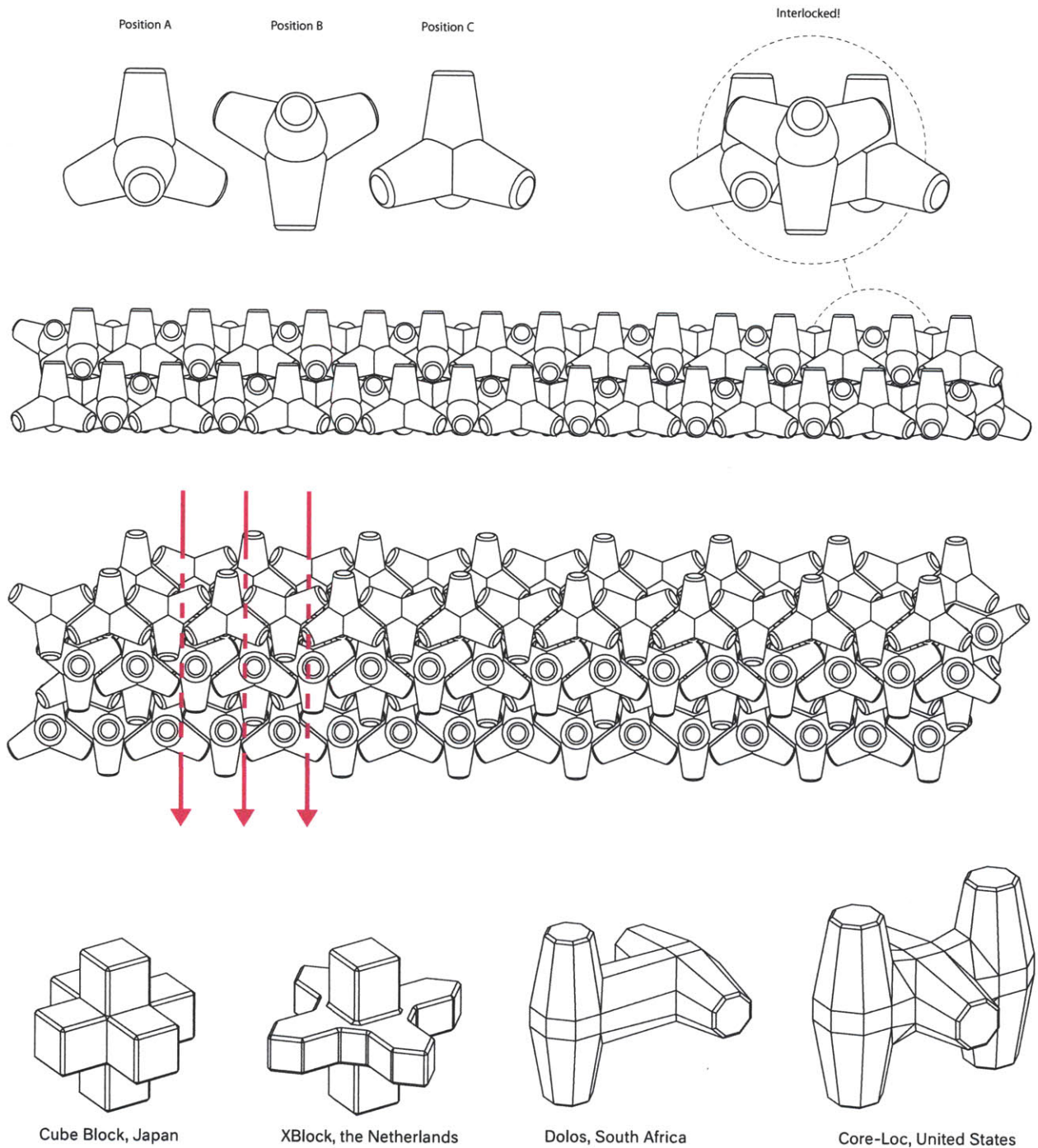
## Maeslant Barrier, Rotterdam





The Maesland Barrier north of Rotterdam is considered the world's largest moving structure. Two kinetic float arms swing shut during storm surges, protecting Rotterdam from flooding during foul weather, but still permitting shipping when not in operation.

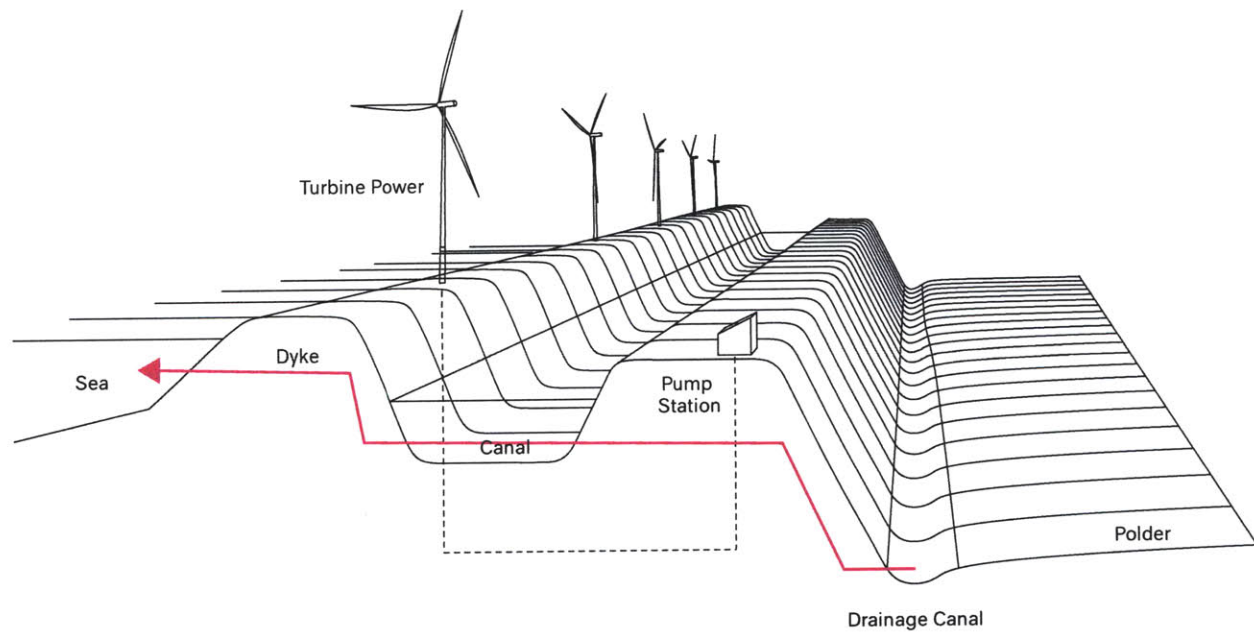
## Tetrapod Armored Breakwaters



Tetrapods are typically used as armoring over earth and rubble breakwaters. Their branching form allows for a random installment while maintaining their capacity to interlock. The porous agglomeration causes water to refract rather than reflect, prolonging the life of the wall.

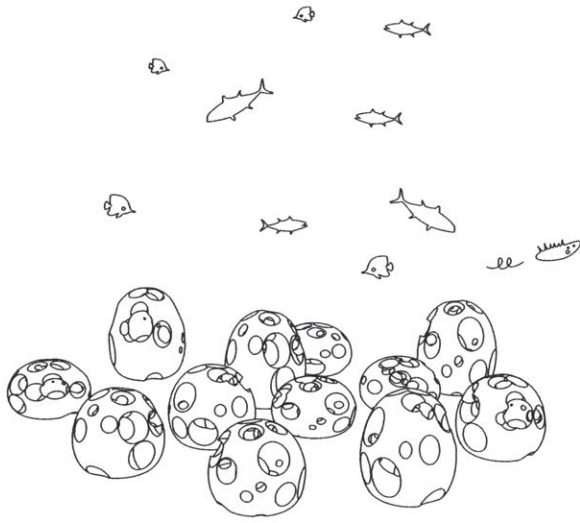


## Tetrapod Armored Breakwaters



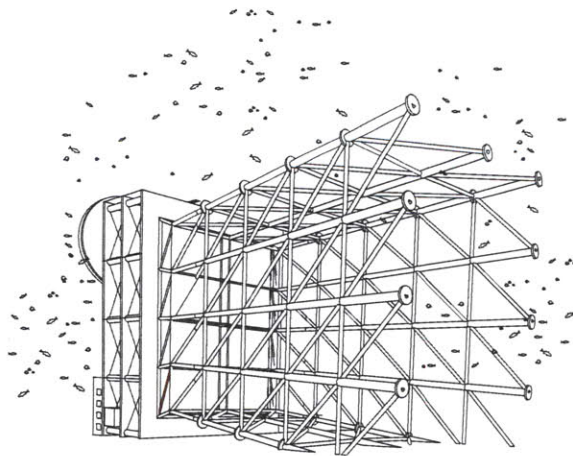
The Netherlands is extensively protected by landscape dykes and levees. Over 25% of country (mostly in the north) is below sea level, maintained by thousands of pumps powered by wind turbines. As sea levels rise, recent policy has investigated the strategic sacrifice of certain polders and communities such that defensive measures can be concentrated in critical regions.

## Artificial Reef Systems



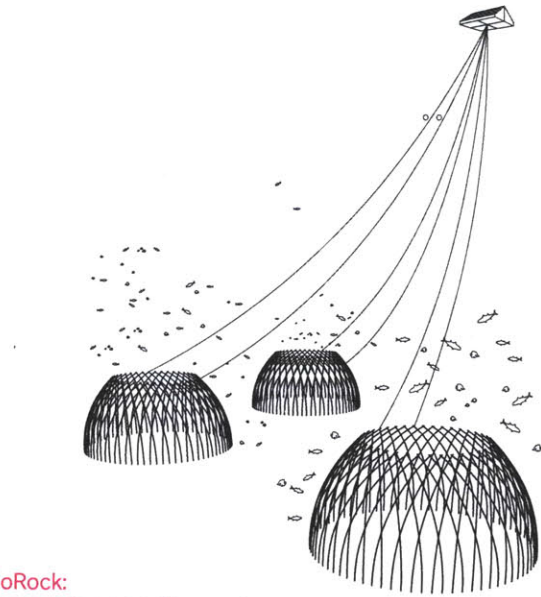
### Reef Balls:

These pre-cast concrete spheres are heavily pocked, allowing for the buildup of mussels and clams, as well as habitat for fish and corals. Reef balls were developed at the University of Georgia, and the Reef Ball Foundation claims that over 500,000 have been deployed in 70+ countries.



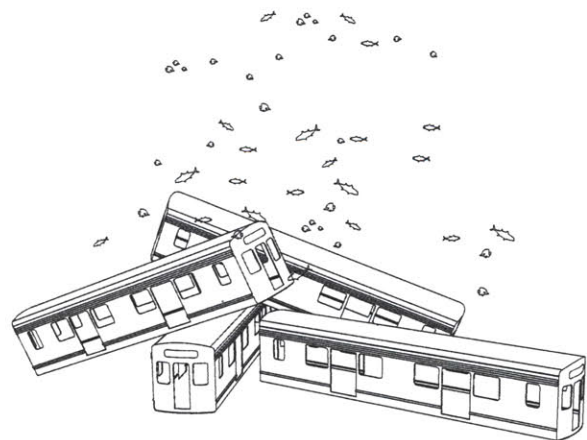
### Rigs to Reefs:

The United States Bureau of Ocean Energy Management, Regulation, and Enforcement sponsors the conversion of decommissioned gas and oil rigs into artificial reef habitat. This can be accomplished by leaving the structural jacket in place, strategically toppled, or blasted and sunk.



### BioRock:

By attaching a positive and negative charge to underwater metal cages, limestone can be grown upon these cages at the rate of 5cm per year. Corals feed upon the limestone, creating a resilient soft infrastructure to manage erosion and produce fishing grounds. Cages can be powered from small solar cells floating on the surface. BioRock was invented in Cambridge, MA, but has been deployed worldwide including the Maldives.

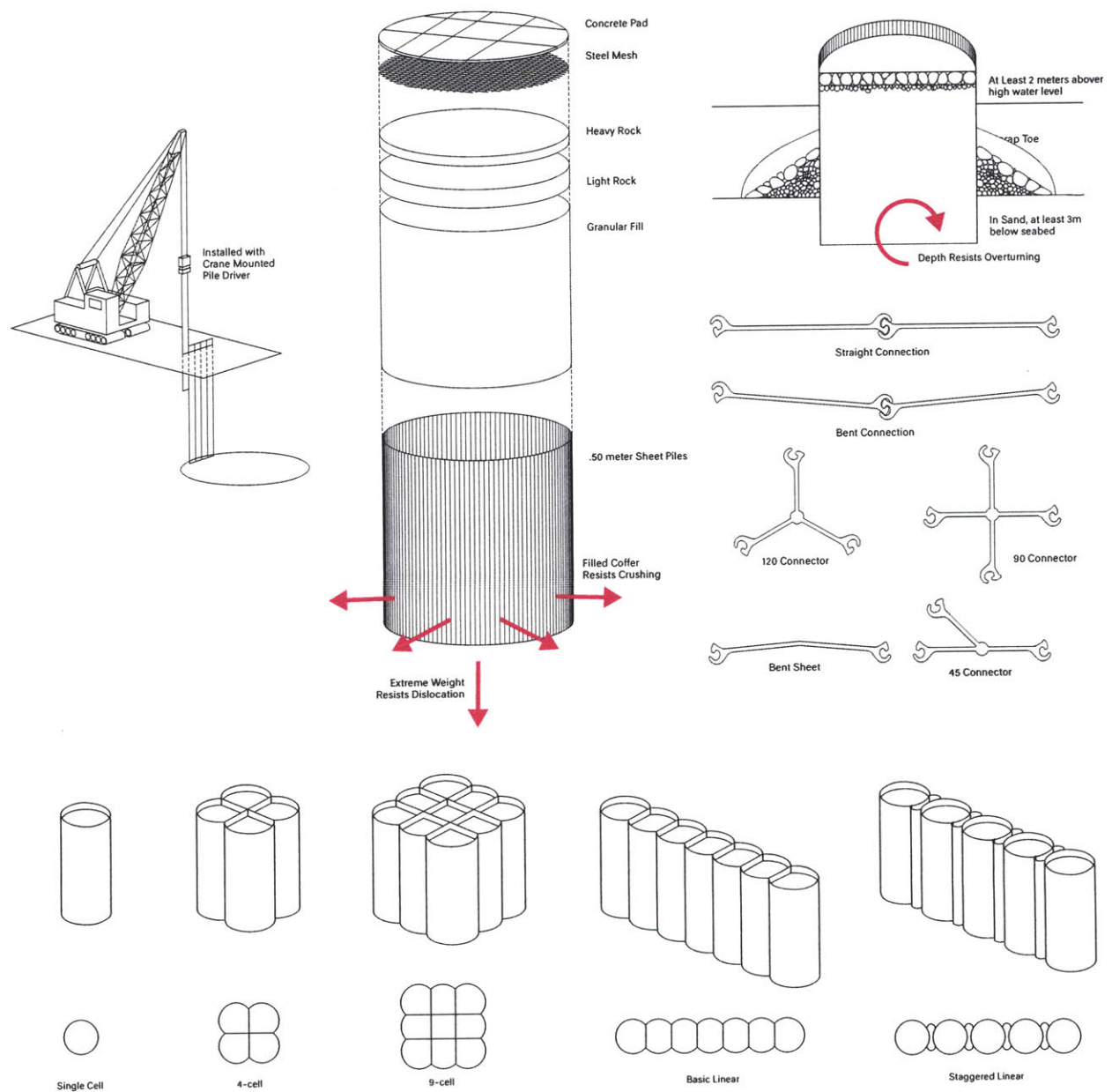


### Rails to Reefs:

In 2003 100 Redbird subway cars from New York City were deployed off the coast of New Jersey on top of existing natural reefs. However, plans to deploy another 550 were halted due to concerns over asbestos, and in 2009 divers discovered that many of steel cars had entirely corroded, calling into question the viability of this strategy.



## Cellular Sheet Pilings



Coffer dams, either circular or straight, produce robust seawalls using a interlocking steel or composite panels to produce a structural diaphragm. This container can then be filled with local debris or soil, producing a system with a minimal amount of import requirements that can be largely constructed from material available locally.



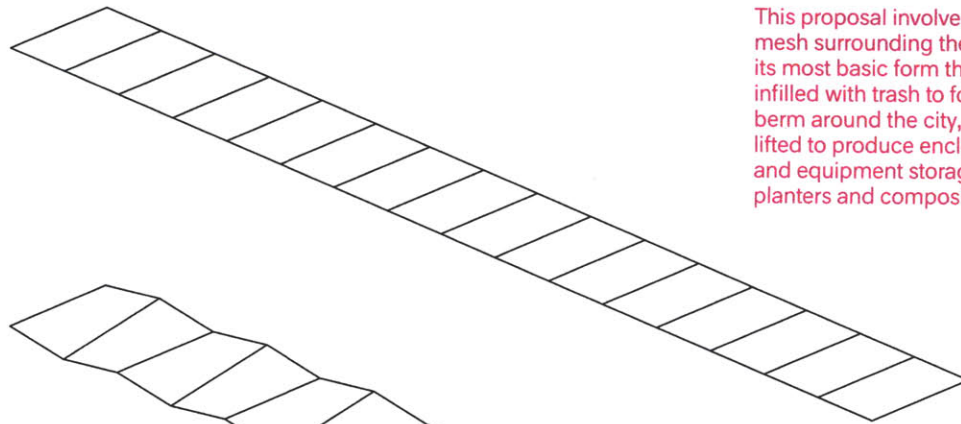


# Process Proposals

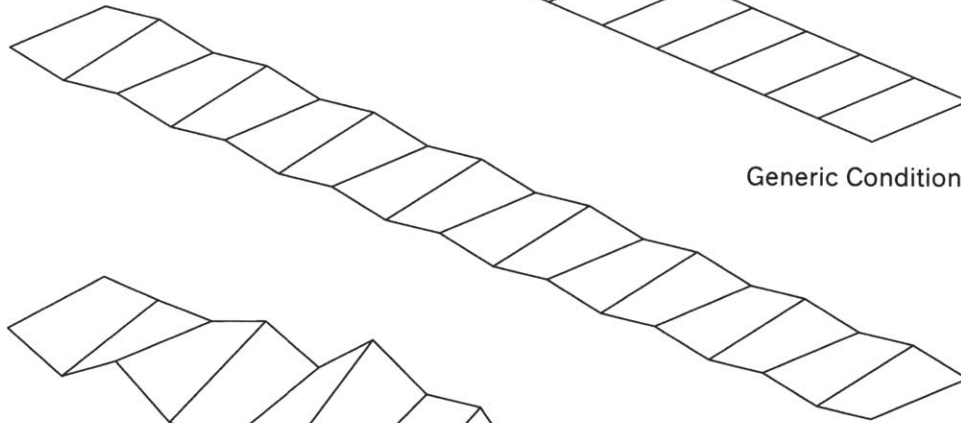


## Imported Geographies: Trash Wall for Male'

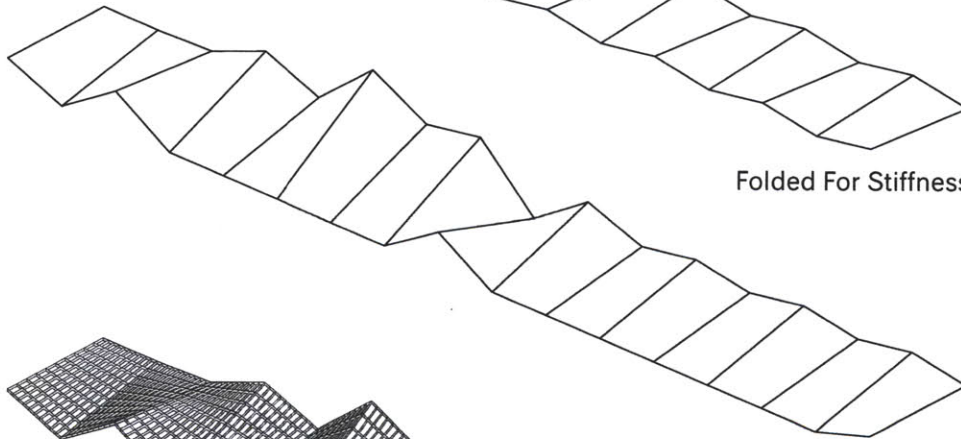
This proposal involves an open steel mesh surrounding the capital island. In its most basic form the frame can be infilled with trash to form a defensive berm around the city, but can also be lifted to produce enclosure for food and equipment storage, or infilled with planters and composite tourist pods.



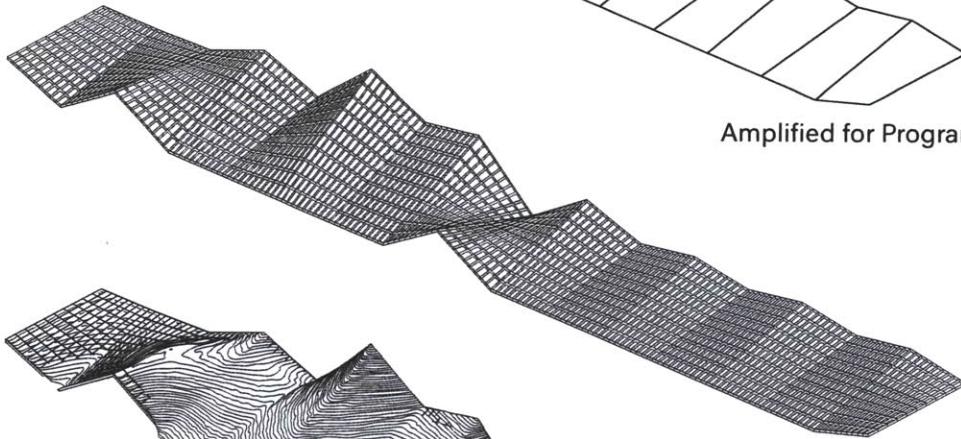
Generic Condition



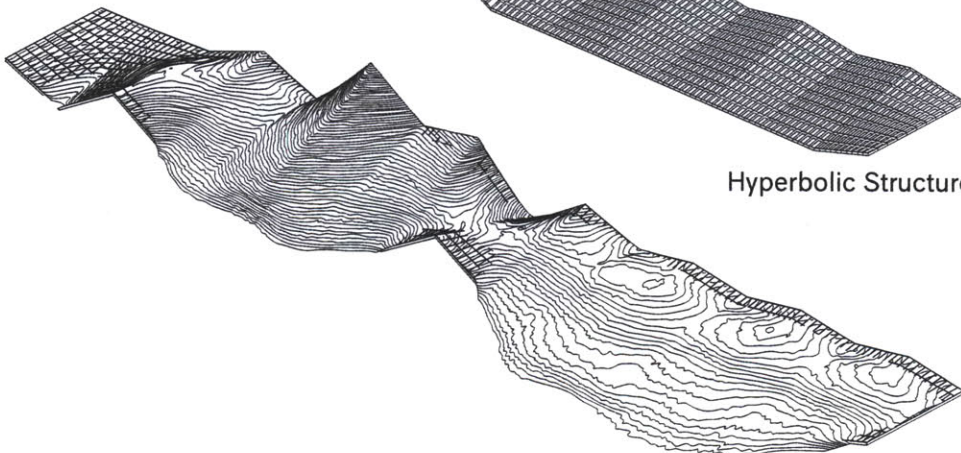
Folded For Stiffness



Amplified for Program

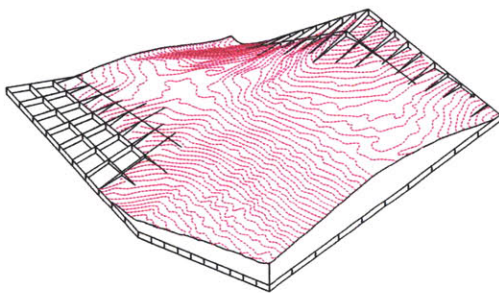
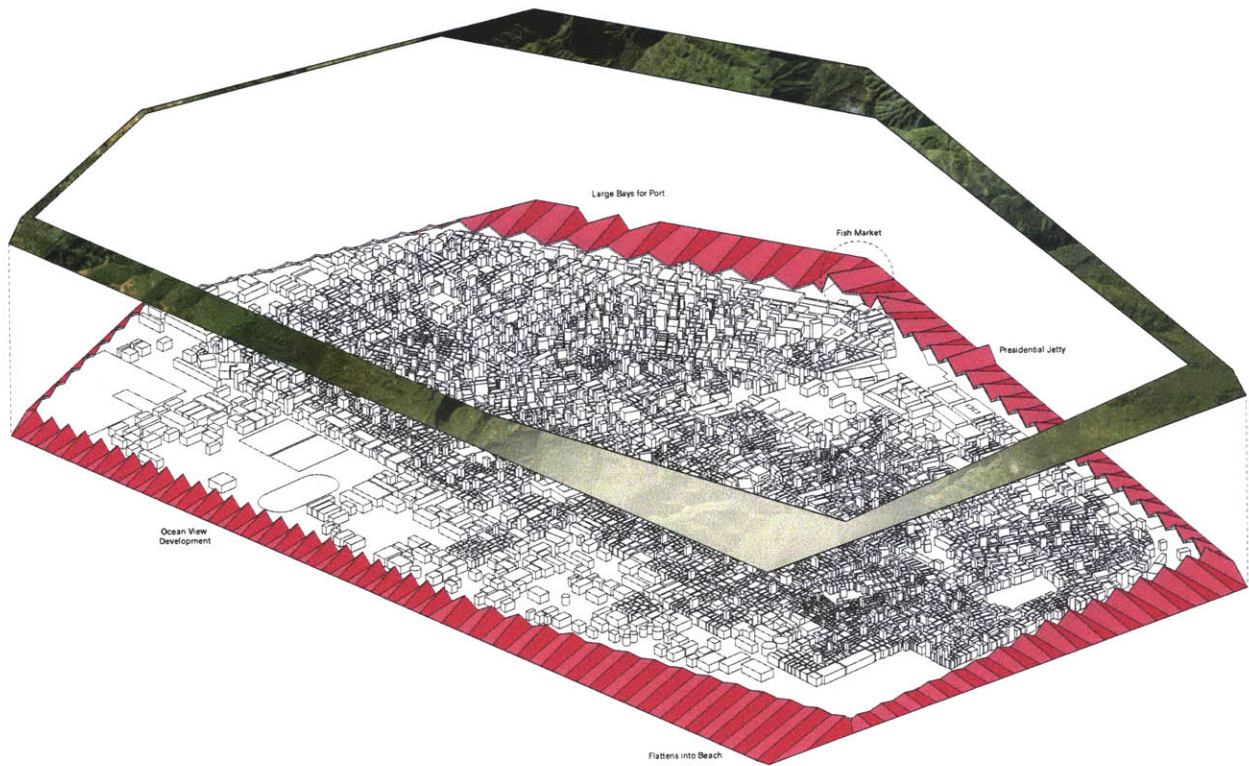


Hyperbolic Structure

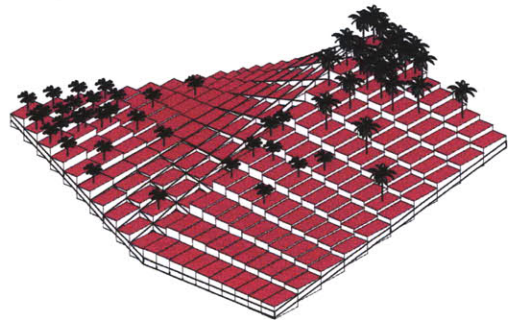


Landfilling

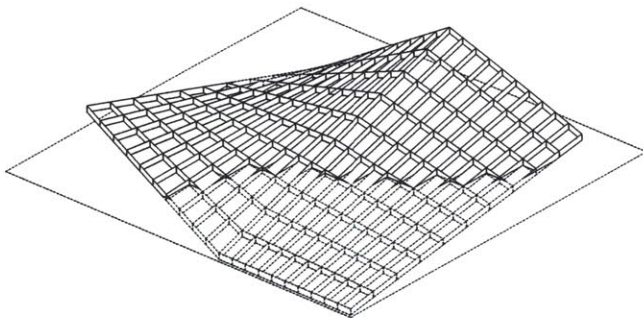




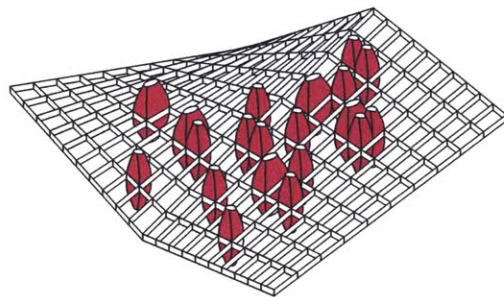
Defensive Landfill



Discrete Planters

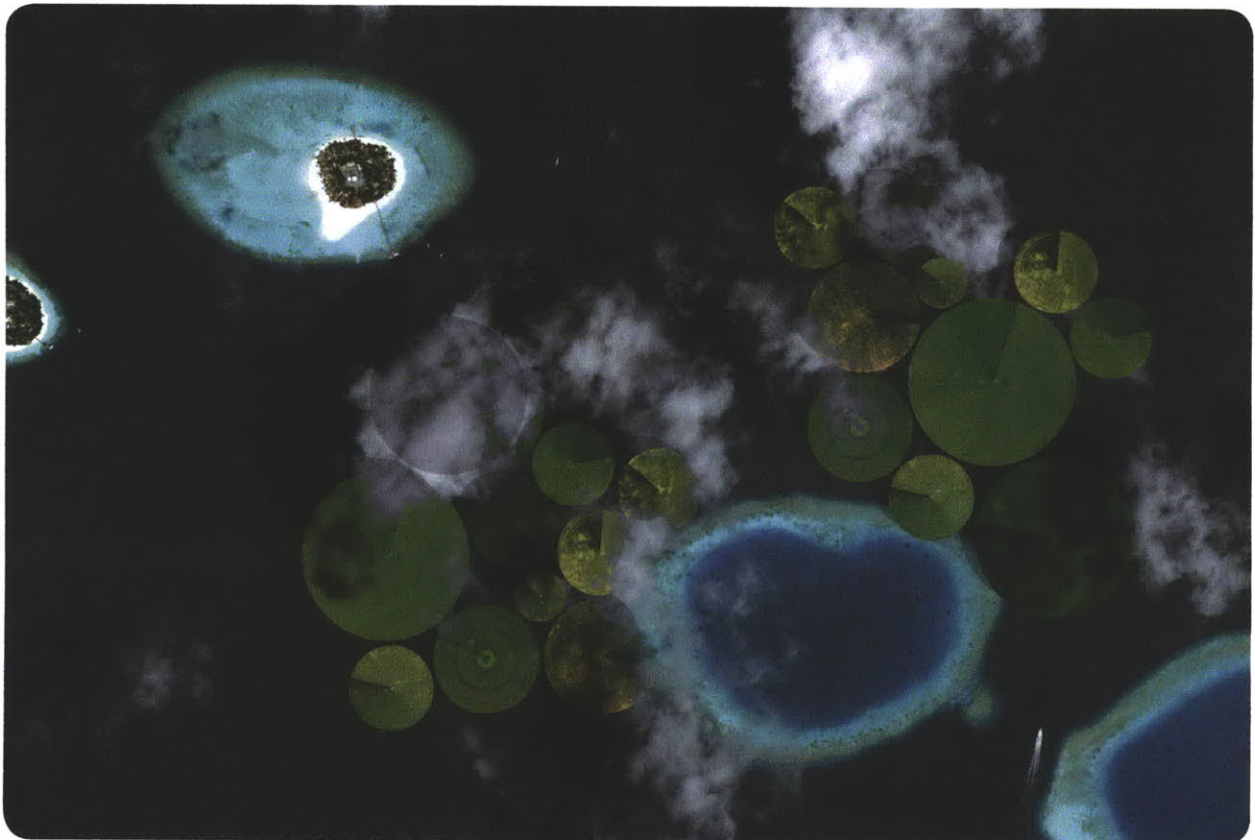
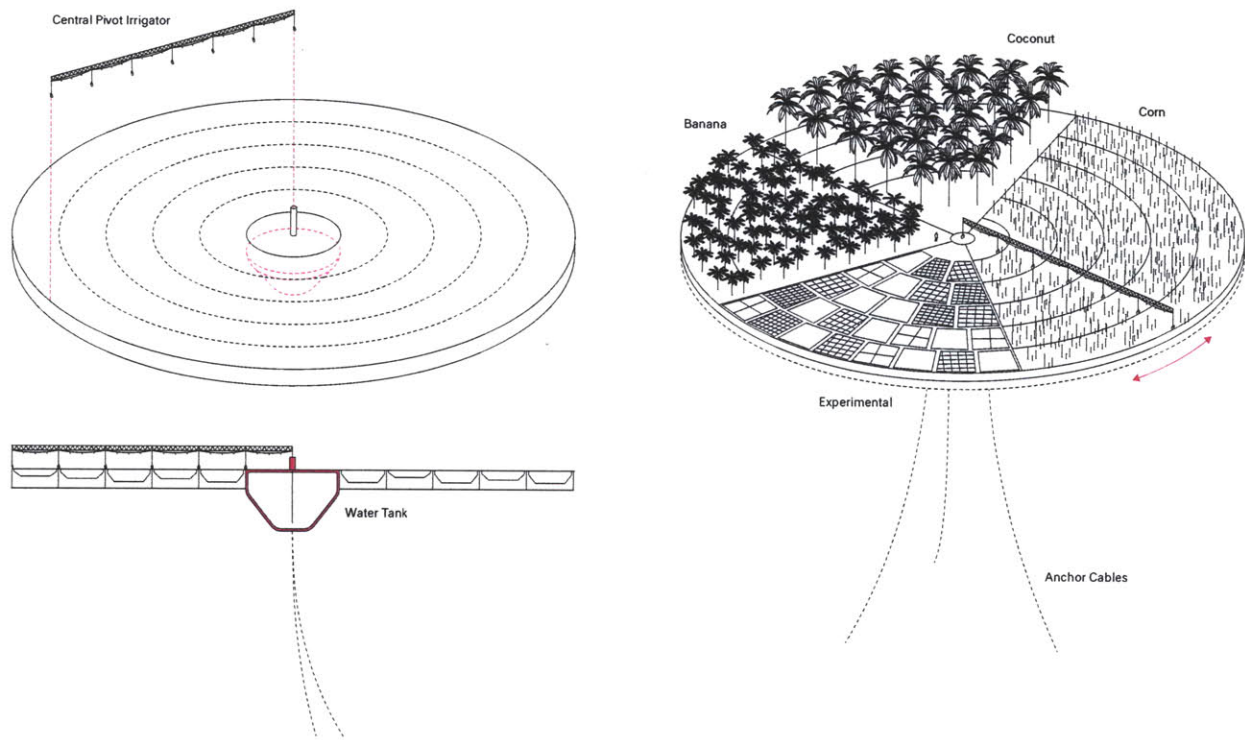


Aquaculture Cages



Storage & Housing Pods

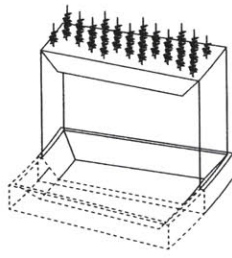
## Farm Pad



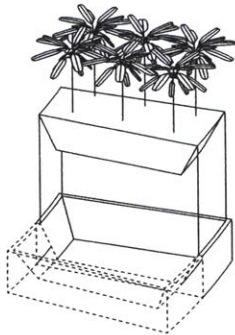




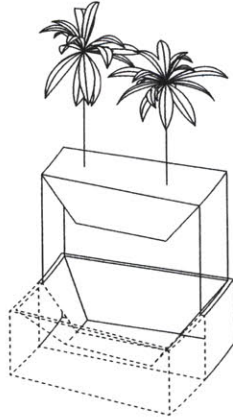
Sea Ranching



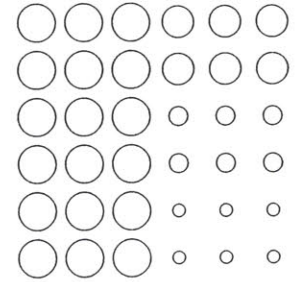
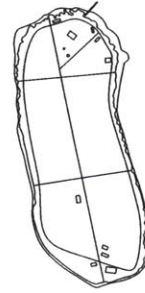
1 meter soil depth



2 meter soil depth



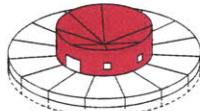
4 meter soil depth



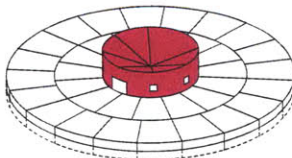
256,000 square meters of farm land



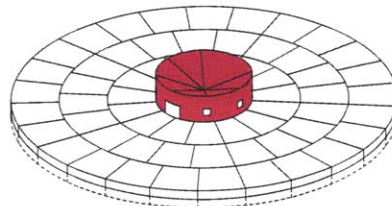
Starter Kit:  
Collector Barn and Water Tank



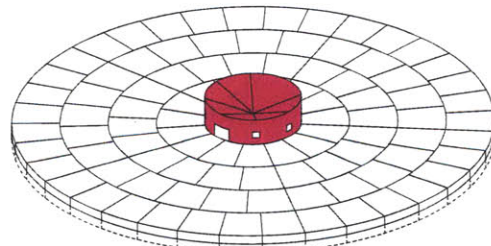
942 square meters



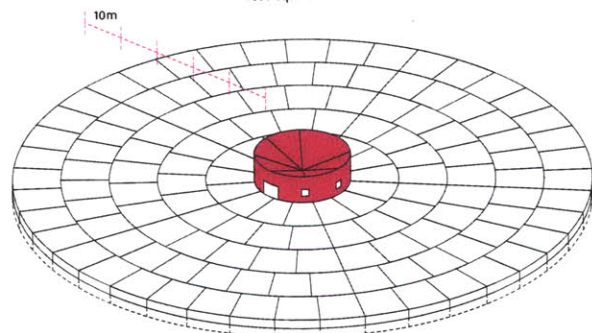
2513 square meters



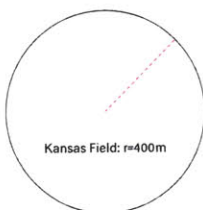
4712 square meters



7539 square meters



10995 square meters



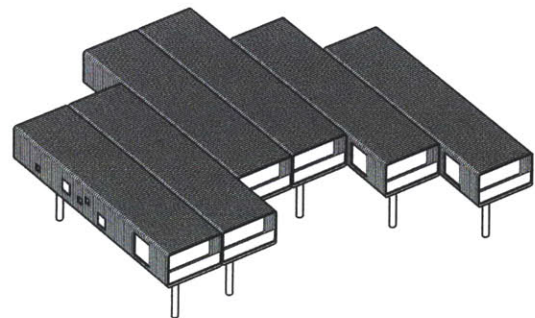
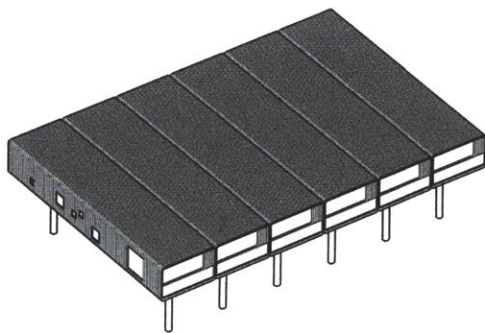
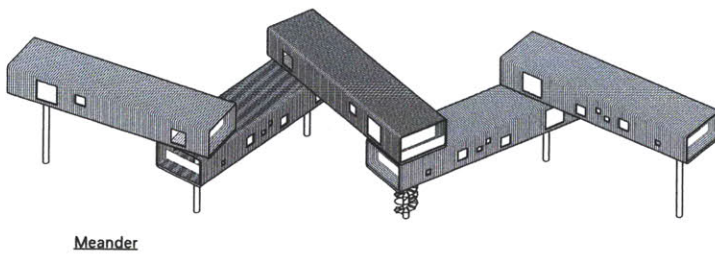
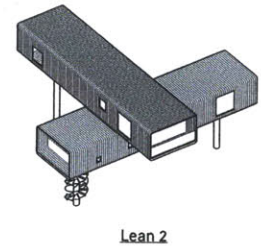
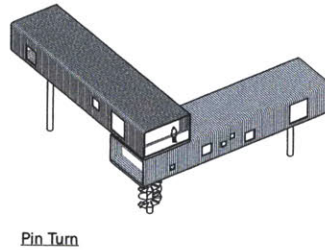
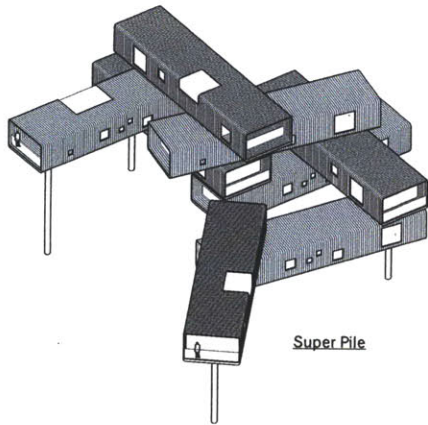
Kansas Field:  $r=400m$

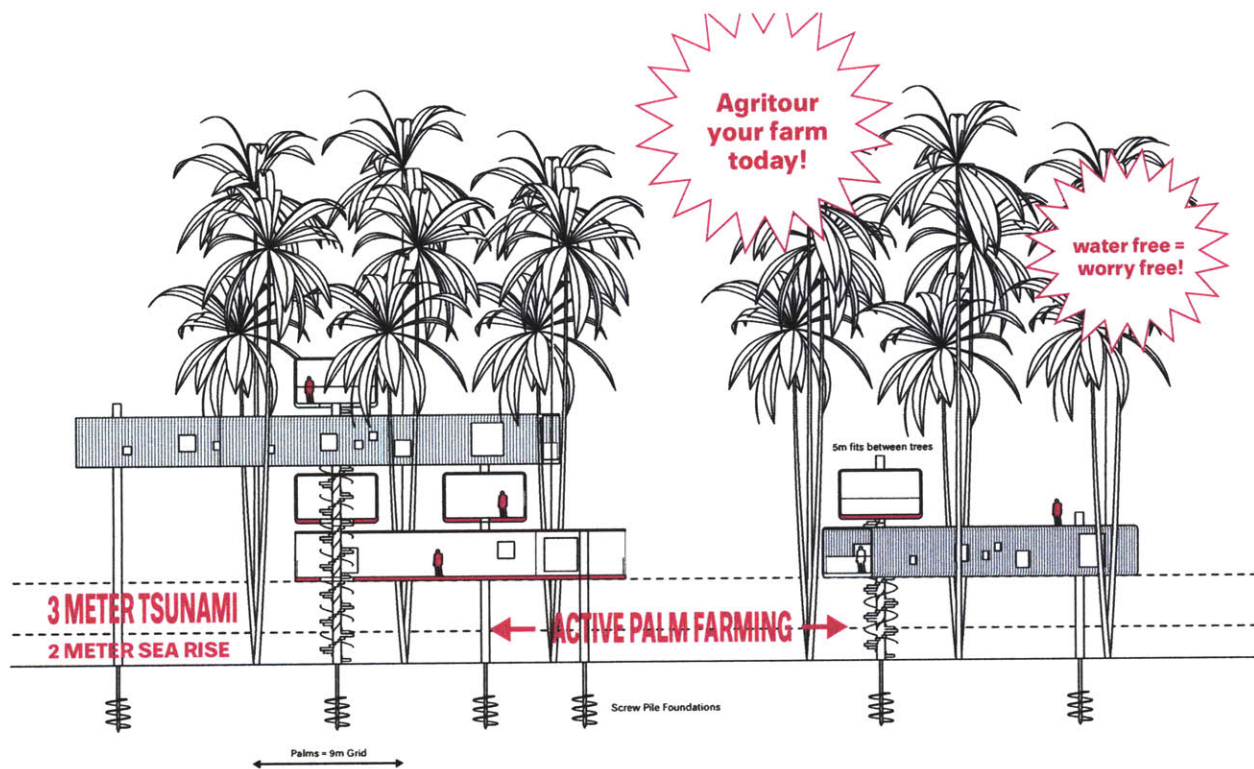


FarmyPad:  $r=60m$

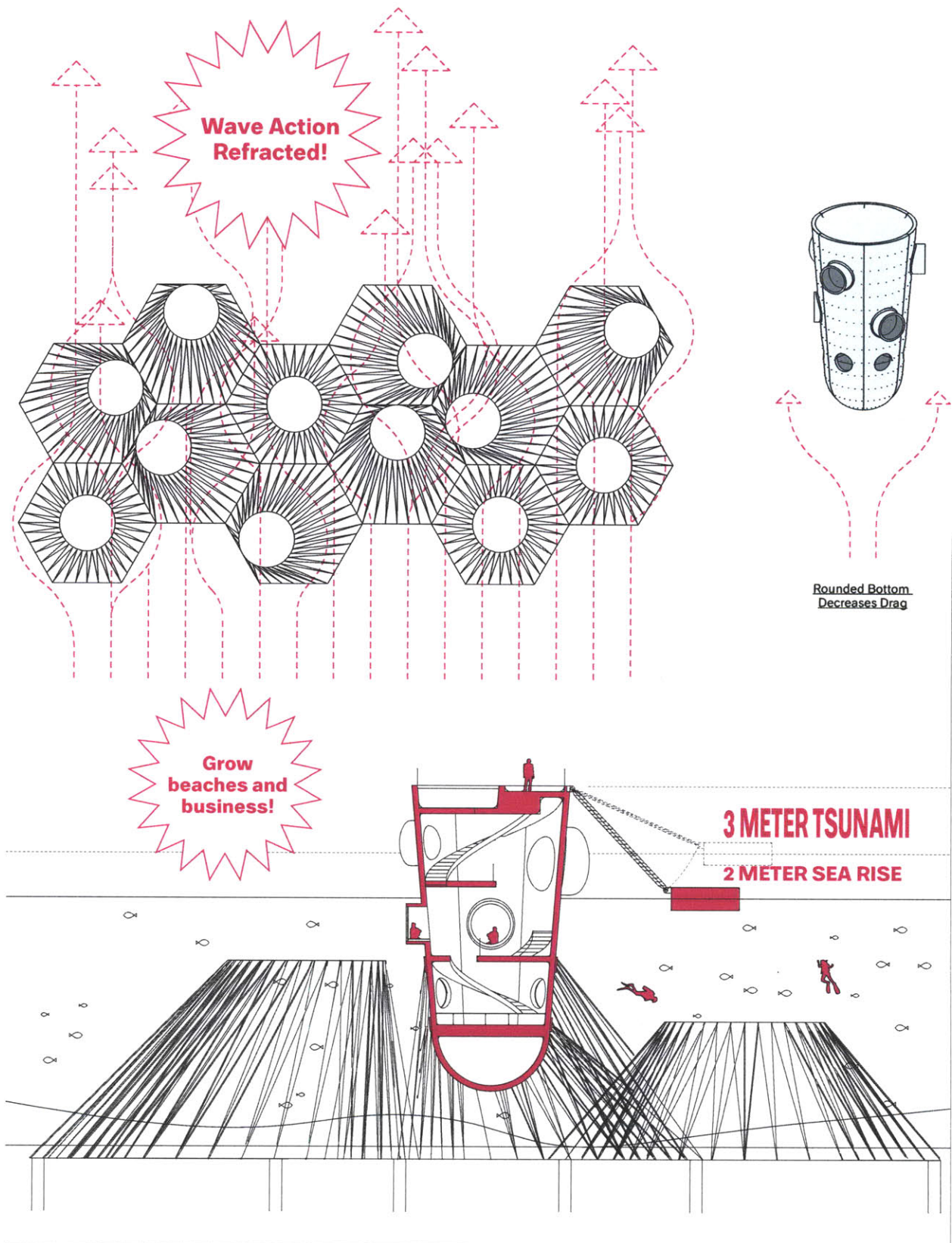


## Treetrahouse Agritourism





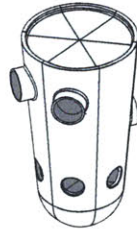
## Breakwater Bungalow v.2



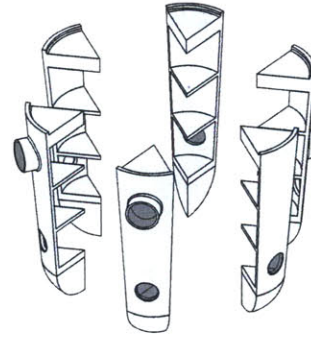




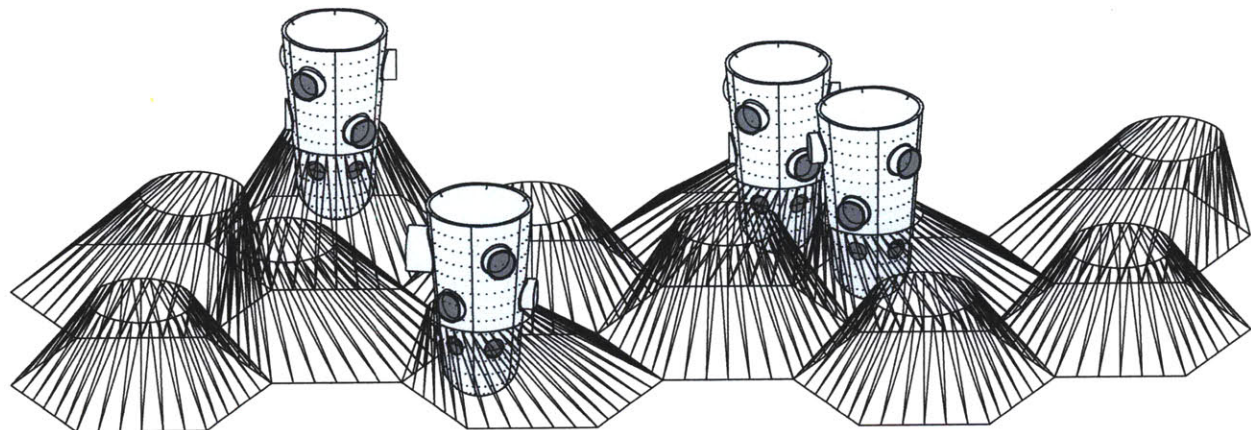
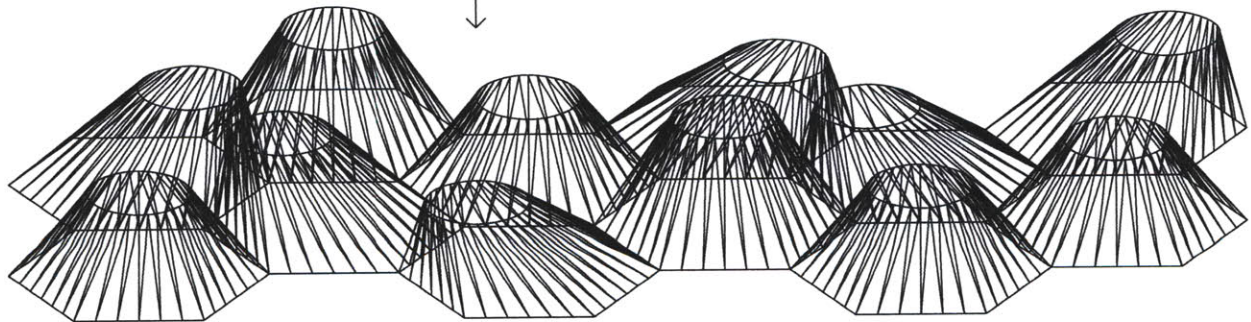
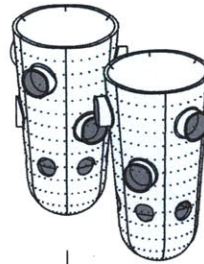
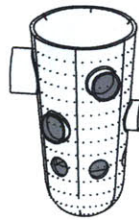
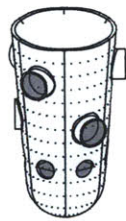
Steel Cage Anchored to Seabed



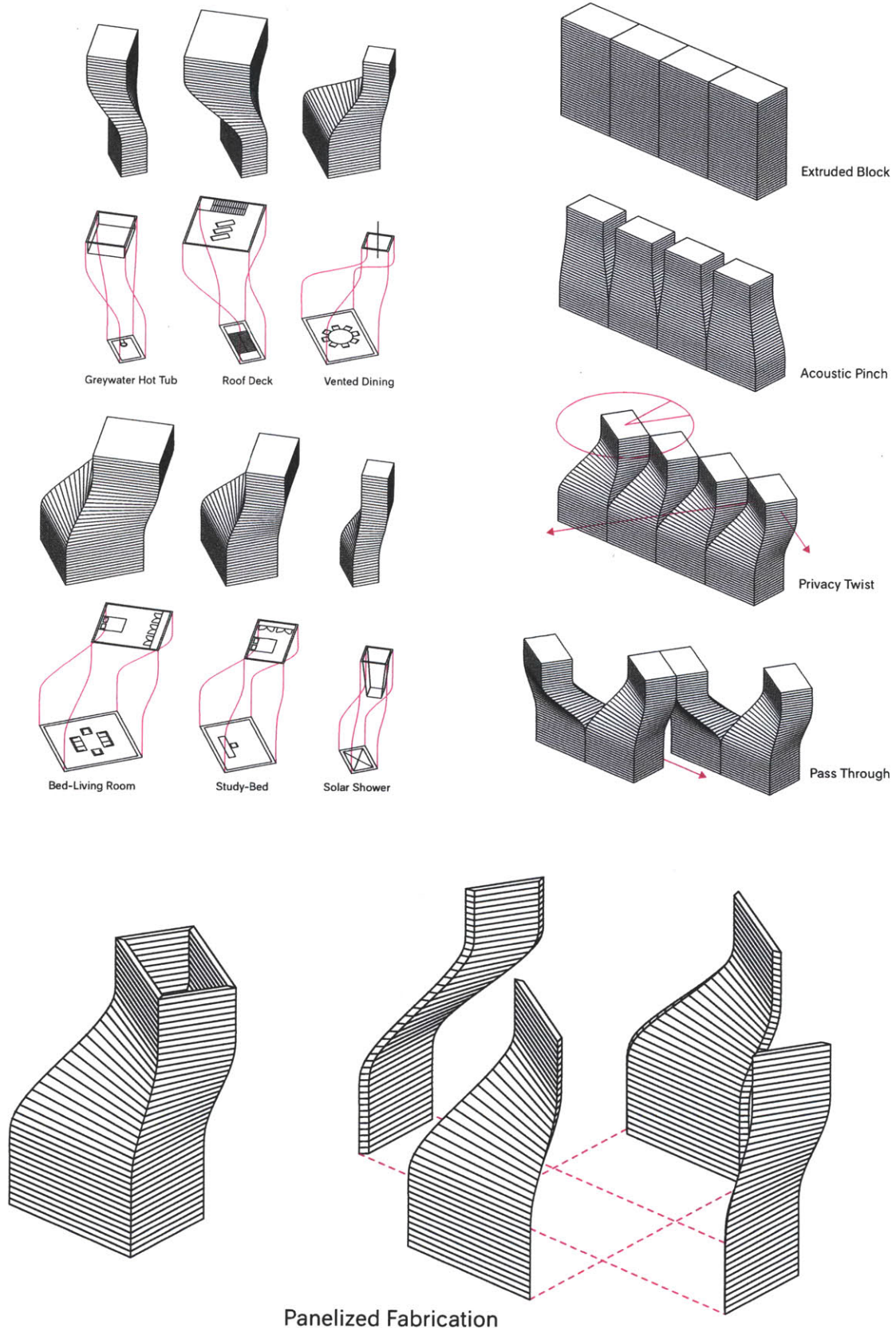
Unitized ReefPod



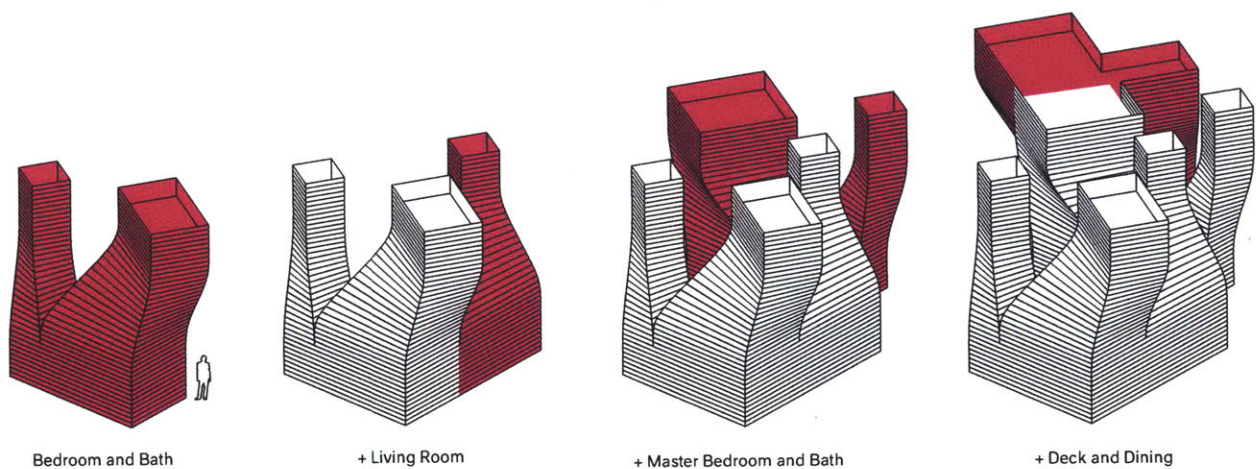
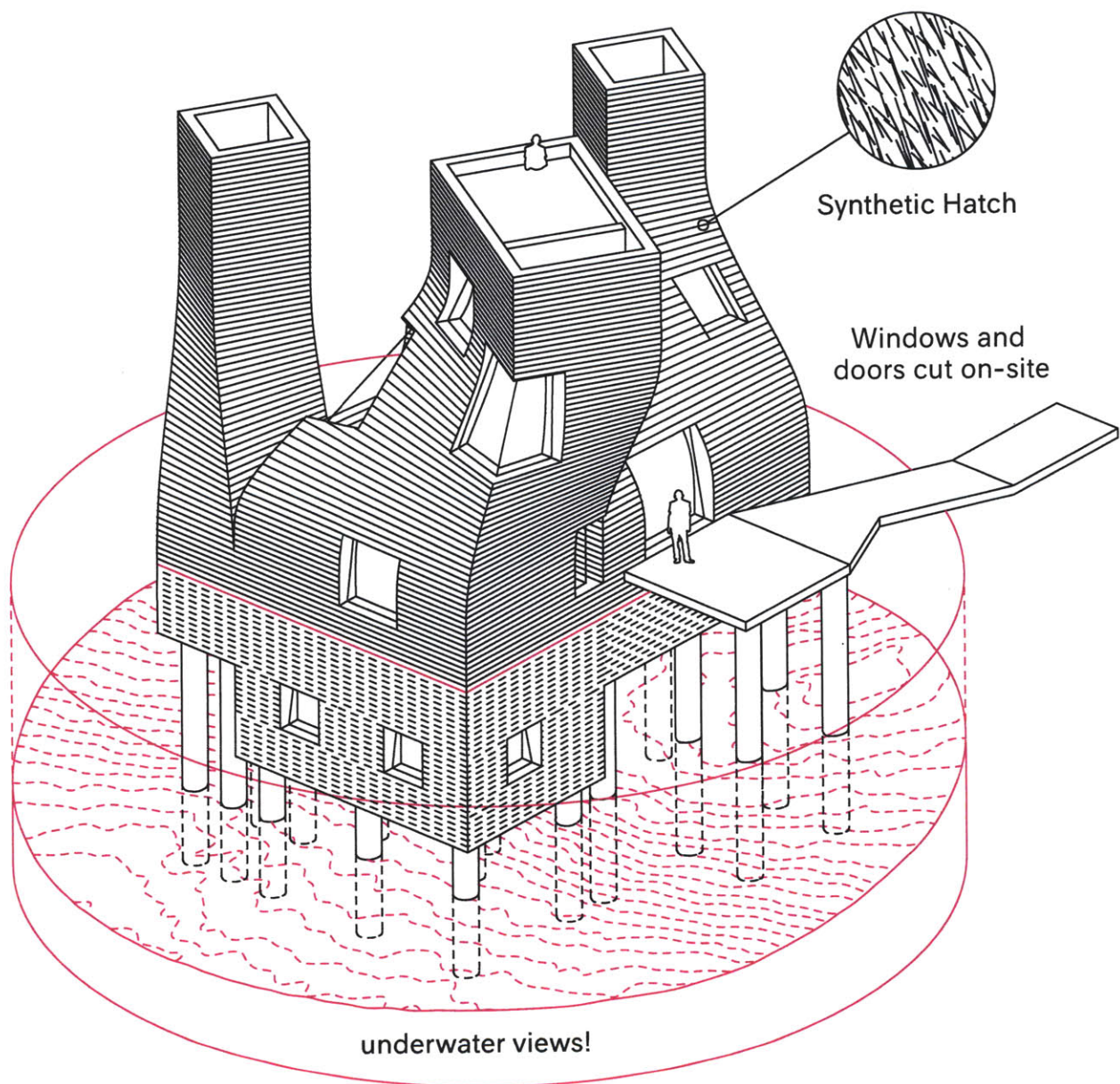
Modular Construction!



## Breakwater Bungalow v.1

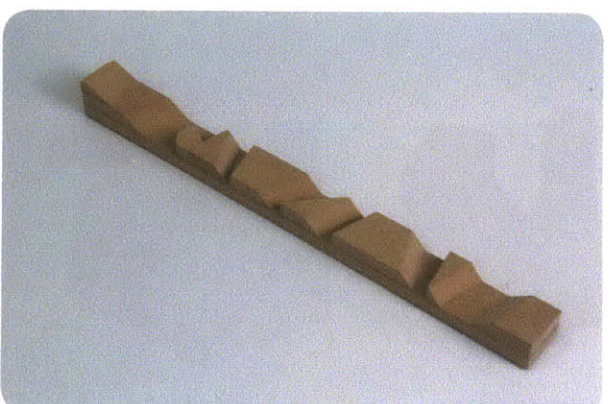
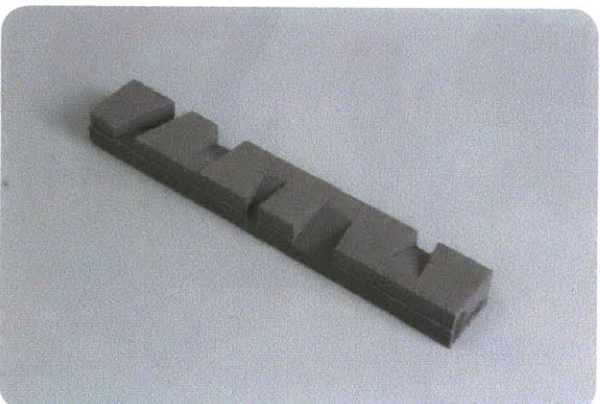
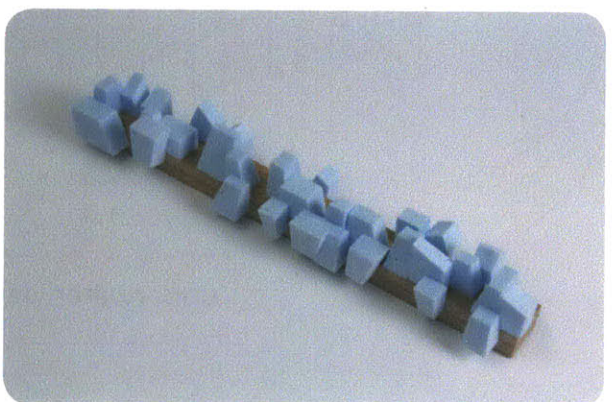
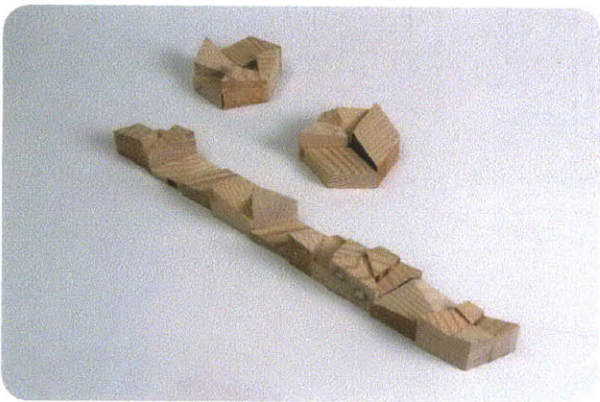
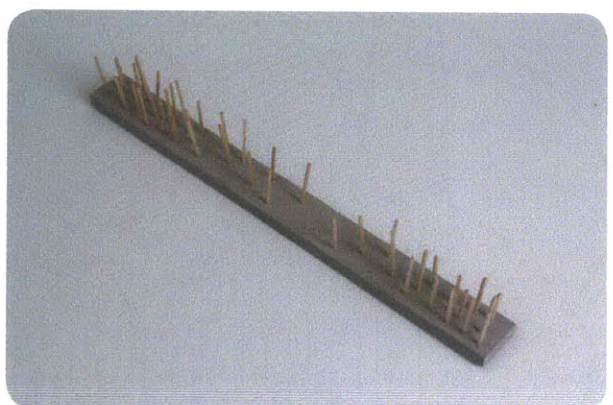
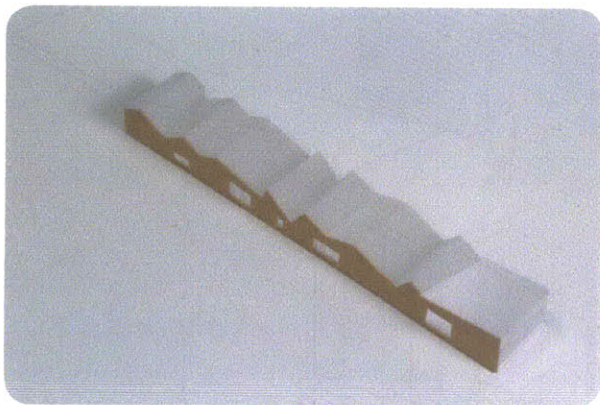
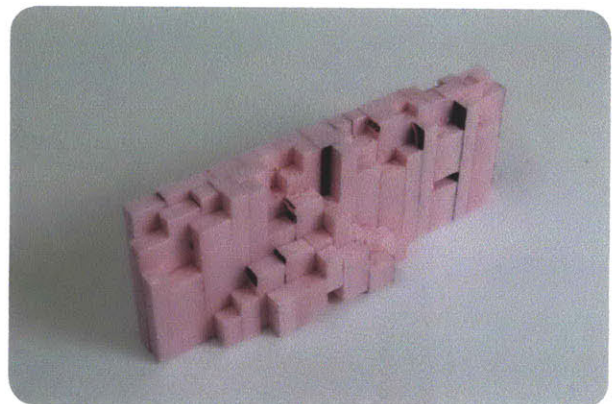
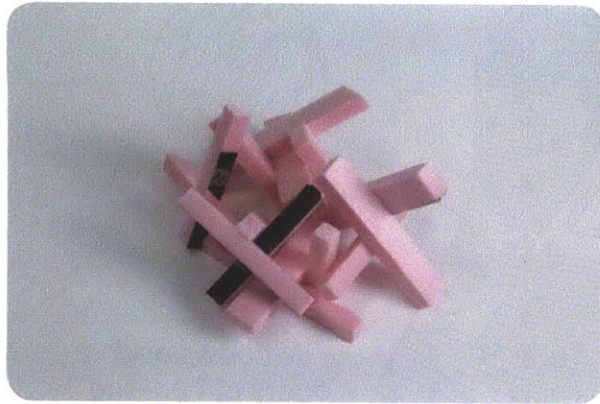






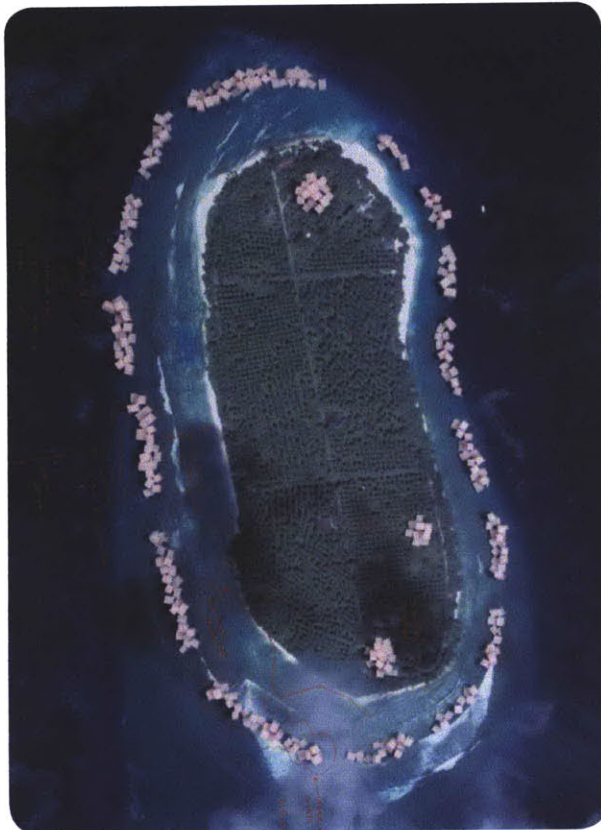
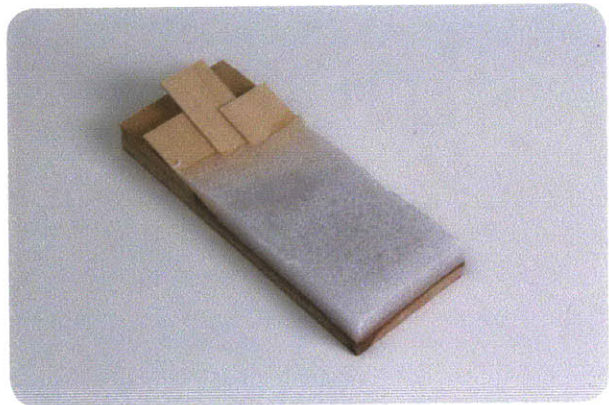
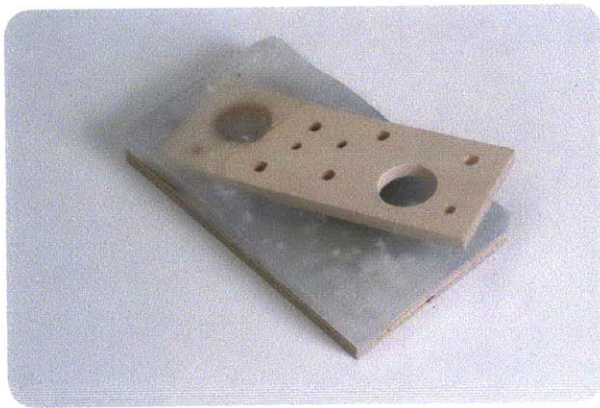
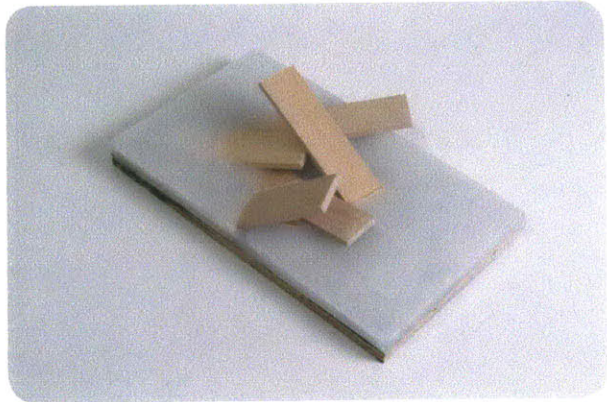
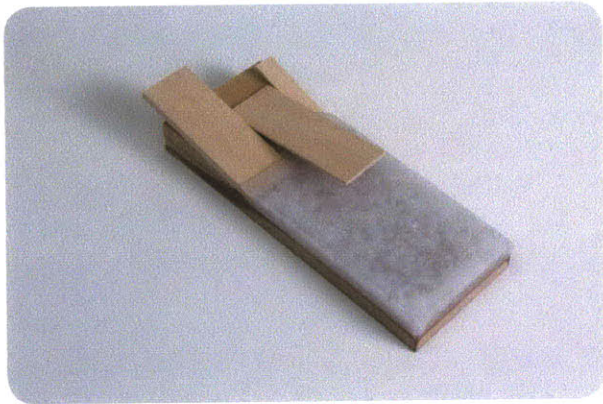


## Conceptual Models



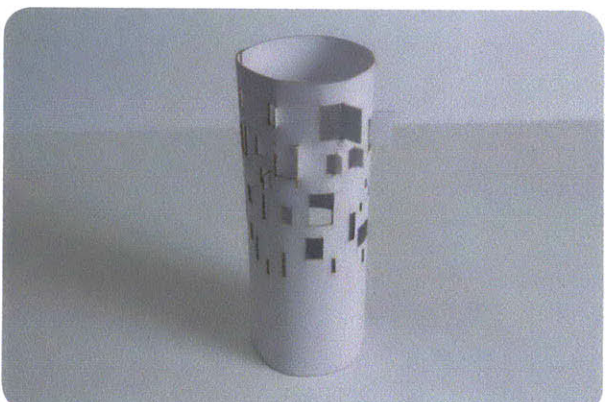
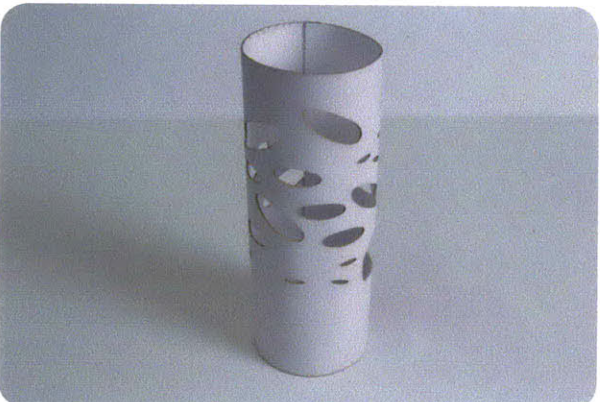
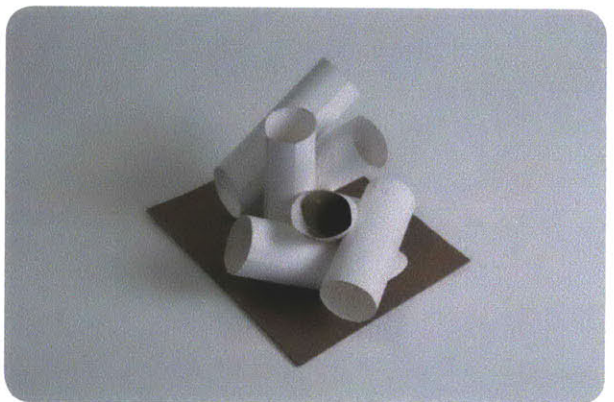
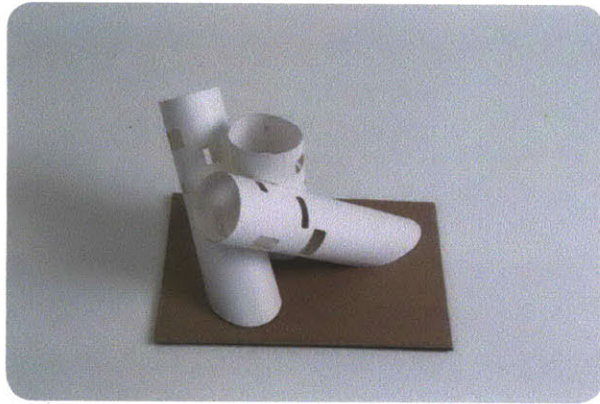


## Conceptual Models





## Conceptual Models









# Appendix





# Paradise Made: The Artificial Islands of Hulhumale & The World

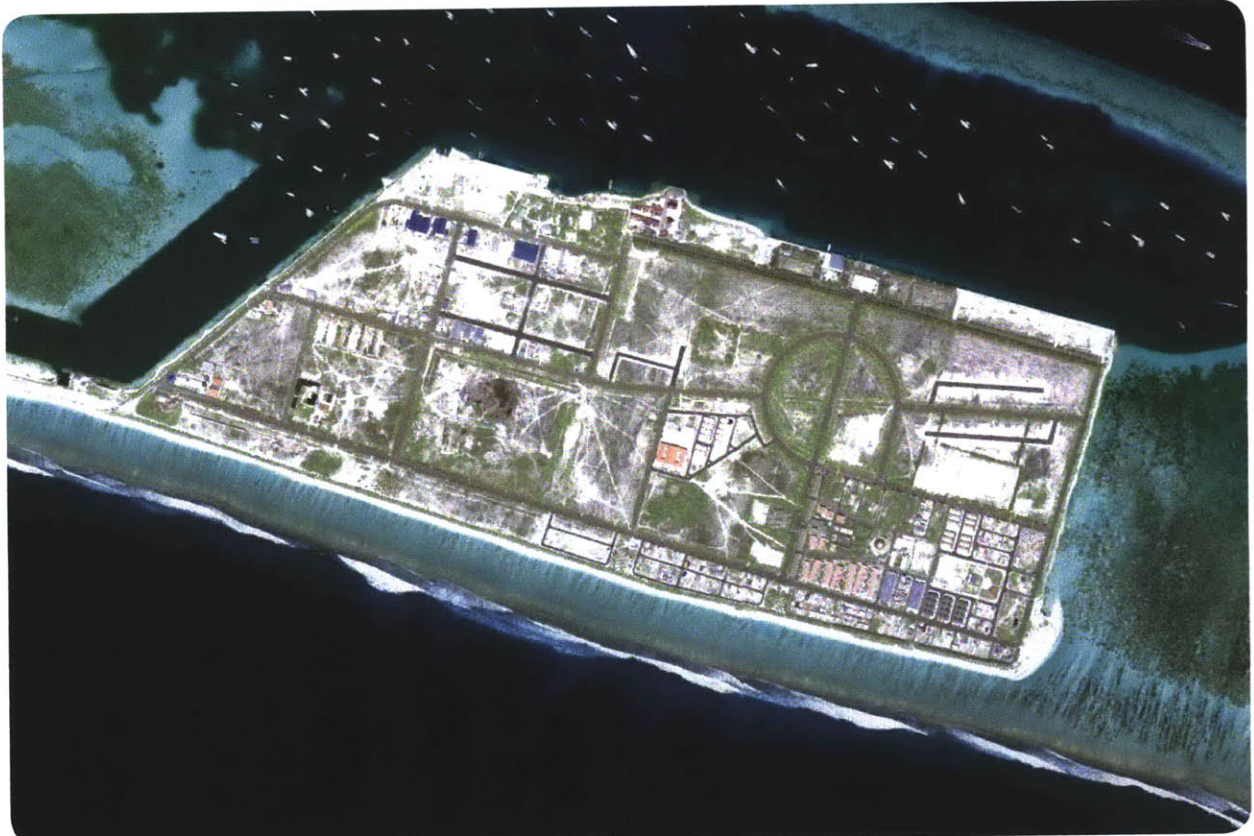
It is curious that The World Archipelago, in Dubai, and the artificial island of Hulhumale, in the Republic of the Maldives, are each designed to produce the exact urban condition from which the other attempts to escape. Each project promotes territorial coastal expansion, utilizing suction cut dredging to form land from shallow sea beds. Though the projects are easily categorized as commercial speculations, they are more critically examined as artifacts of global crisis, specifically: peak oil and the related increase in sea levels and storm surges due to climate change. The conflation of these crises and burgeoning coastal populations has produced an urgent redevelopment of marine environments. Hulhumale Island and The World Archipelago manifest solutions to these looming catastrophes through typological radicalization in addition to technological intervention.

## **On Hulhumale:**

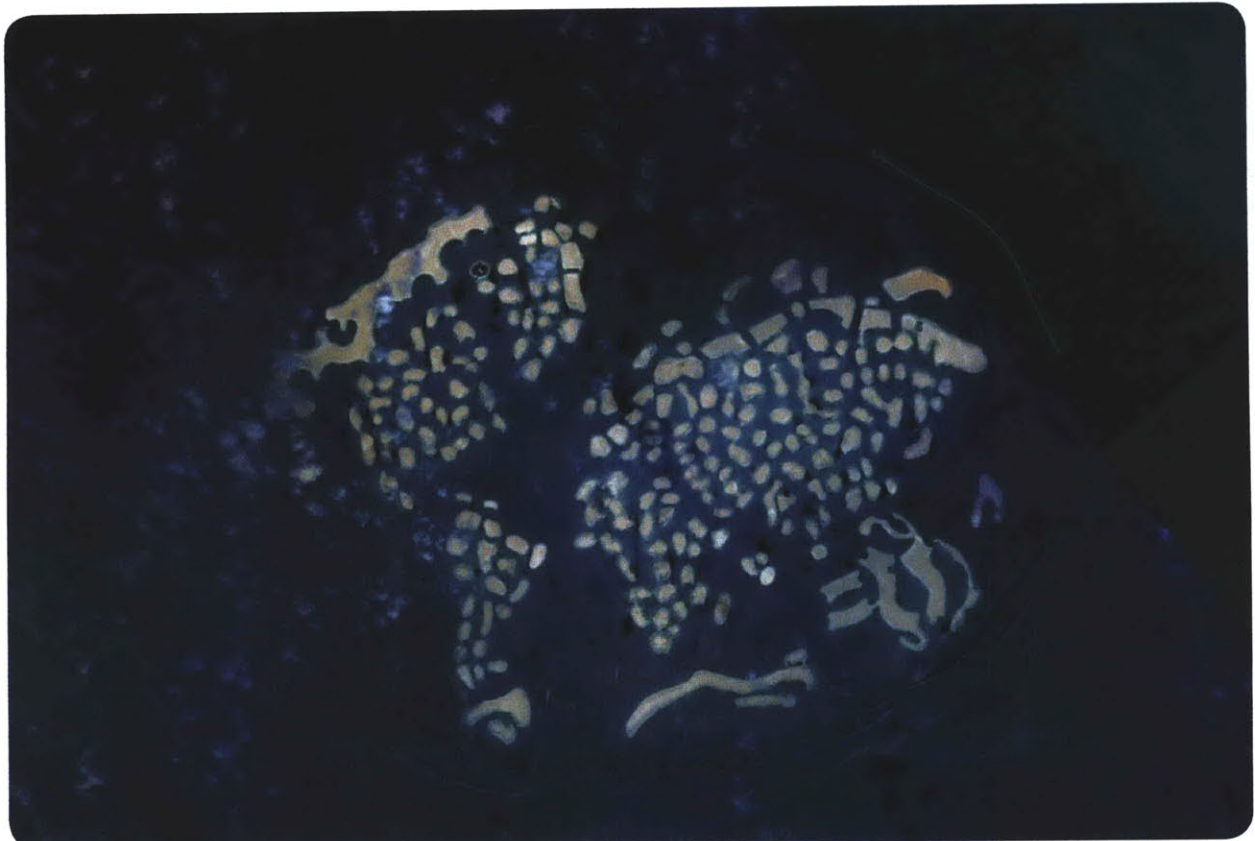
Hulhumale Island is the product of two pressures in the Maldives: a devastating local housing shortage, and a nation-wide vulnerability to storms and tsunamis. The Republic of the Maldives consists of 26 atolls composed of some 1200 small islands; with an average height of just one meter, they are likely to be the first nation entirely inundated by rising sea levels. Along with other small island nations such as Tuvalu and Kiribati, the Maldives are at risk of losing their sovereignty as oceans rise a predicted 1-2 meters in the next century. In 2004 the Indian Ocean Tsunami underscored this vulnerability, swamping the entire capital of Male and killing 120 people throughout the country.

Construction on the Hulhumale project began in 1997 under the direction of ex-President Maumoon Abdul Gayoom. Gayoom's failed appeals to larger industrialized nations to curb global emissions of greenhouse gases have inspired a series of infrastructural experiments throughout the Maldives, beginning with a 1987 project sponsored by the government of Japan to construct a 3-meter tall breakwater around the entirety of the capital. (NPR) Though the island was largely protected from wave damage in the Indian Ocean Tsunami, the imposition of this wall has done little to address the future development of the country.

What is now Hulhumale began as a large lagoon along the northern edge of Male' International Airport, and through the oversight of the Belgian conglomerate DEME (Dredging Environmental & Marine Engineering) was incrementally filled in through a process called



Hulhumale



The World

suction cutting and dredging, whereby a vessel deploys a cutting head into the seabed to break up sand and coral, which is then vacuumed to the surface and repositioned by water cannon. In 2004, after relocating more than 4 million cubic meters of from the nearby seabed at a cost of 19.7 million dollars, Hulhumale was inaugurated with roughly 1000 residents. This first phase of expansion, roughly the same physical area as the capital island, albeit 1 meter taller, should eventually house 50,000 people. (ARAMCO) A second phase, which will double the island by expanding to the north, plans for a total population of 150,000.

According to the Housing Development Corporation, [or HDC,] which oversees the progress of Hulhumale, the island was conceived to expand the economic base of the country by increasing its buildable surface, with a specific intention to promote fisheries and tourism, which together collect the majority of economic revenue in the Maldives. To this end, the master plan has divided Hulhumale into a series of parcels defined by type. Residential and hospitality areas with the highest economic potential have been deployed to the shore, to take advantage of ocean breeze and views. Inland, an academic district and a commercial zone surround a central core of government offices. To the South, a new national stadium and industrial park serves to block both the sight and sound of the nearby airport.

This urban strategy is divergent from recent developments in the Maldives in that it seeks to condense the entire country's municipal and economic infrastructure into a single location. An examination of the Maldives in the last half of the 20th century reveals a pattern by which most programs are deployed to follow the geographic paradigm of many small and isolated islands; that is to say, each single land mass typically maintains a single element or program. In the immediate vicinity of Male, individual islands have been developed to accommodate infrastructures in support of the capital, including an extensive landfill and industrial sector, a ship refueling depot, a prison, an airport, a farm, and a variety of hotels and resorts. Though some infrastructure exists on Male itself, such as a diesel powered energy plant and



desalinization services, the capital is maintained as the cultural and political center of the country.

Curiously, Hulhumale does not introduce new elements of municipal infrastructure, but specifically creates a redundancy with programs already in existence, including the primary government offices, foreign embassies, the national stadium, and a new academic campus. Hulhumale is linked by causeway to the airport, facilitating a shift in primacy from the helicopter or boat to the automobile. The development of central services is recent, directly related to the rapid expansion of the Maldives since its independence from Britain in 1965. In this period, the country's population expanded more than 400 percent to 350,000 people, driven by a state-led effort to transform the Maldives into a tourist destination. What had been a series of largely autonomous islands has quickly become a collection of dependent states with a centralized seat of government.

Hulhumale is symptomatic of a shift from localized independent infrastructures to a reliance upon imported commodities and economies. As of 2009, only 7% of food consumed in the Maldives food is produced in-country.

### **On The Nakheel Archipelagos:**

Concurrent with the creation of Hulhumale in the Maldives a similar mode of territorial expansion has occurred in the shallow waters off of Dubai. The Nakheel Archipelagos are a series of artificial islands created through suction cut dredging by the Dutch contractor Van Oord. Nakheel Properties, the projects' developer, is a subsidiary of Dubai World, which is in turn the primary investment manager for the government of Dubai. Therefore these territorial expansions are not normative third-party commercial ventures, but investments in national infrastructure by the state itself.

The first of these islands, the Palm Jumeirah, is claimed by Nakheel to have literally doubled the shoreline of Dubai, and offers between 4000 and 8000 properties upon which beachfront homes and luxury homes have been constructed. According to Van Oord, the project contractor, the island was constructed by reclaiming over a billion cubic meters of sand from the 10.5 meter deep water, which is then surrounded by a breakwater to keep the vulnerable new land from eroding. Once this first phase had been completed, a 100 meter channel was cut upon the trunk of the palm, officially making the Palm Jumeirah the world's largest artificial island.

Nakheel's most recent endeavor, The World Archipelago, consists of 300 individual islands in the general shape of the 7 continents. This project, for which the land reclamation was completed in 2008, will add an additional 232 kilometers of beachfront to the city, though at 4 kilometers off the coast, it will be radically exclusive.

The world is divided into four primary island typologies. Single-residence estates are zoned towards the perimeter, ostensibly for better ocean views and privacy. Mid-to-High density development is intended for a large groupings of single family residences. Resorts, sold in packages of 3-6 islands, provide space for larger developments, and finally, commercial hubs are located to coincide with a series of strategically located transportation hubs. If one is to believe Nakheel, residents can travel back and forth between these hubs and the mainland by high-speed ferry in as little four minutes.

Land reclamation was finished by Van Oord in 2008 with the completion of its own defensive breakwater. Properties are transferred to their new owners as little more than a flat expanse of sand reaching one to three meters above the water; working within the World zoning laws and setbacks, each owner is free to terraform the islands into their own particular vision of

beaches and harbors. Nakheel's efforts in this sense are largely infrastructural, producing the foundations for development without dictating its final form . To support the water and energy loads, service stations are placed at the east and west breakwaters, connecting the 300 islands through a series of utility corridors, and then linking them through a main back to the city.

In November of 2009, Dubai World announced that it would be unable to make further payments on its debt in the wake of the 2008 credit crisis (Marketwatch), effectively halting all progress on The World Archipelago. According to the project's website, the World was officially completed on January 10, 2008, with an announcement that handovers to individual construction managers would soon begin. As of the Spring of 2010, only the model island, which was completed in 2005, is anything more than a low pile of sand blowing back into the Persian Gulf.

### **On Crisis:**

Decline, in a sense, has been a certain future for Dubai, whose oil resources are predicted to be entirely depleted by 2020. (Cities from Zero, 83) Shumon Basar submits in his essay Twelve Ultimate Critical Steps to Sudden Urban Success, that by 2020 Dubai "will have translated 50 years of oil lubricated wealth into an ever expanding portfolio of industries." Oil revenues now make up only 25% of the United Arab Emirates Gross Domestic Product, which has been diversified to depend instead upon tourism, property management, and financial services. (CIA Factbook) Super scaled projects such as the Burj Dubai, Dubai Ski, and the Nakheel islands have transformed Dubai's wealth from resource to spectacle.

Amale Andraos, [in an essay entitled Dubai's Island Urbanism: An Archipelago of Difference for the 21st Century,] argues that the urban form of the World development is not itself a



radical proposition, but rather a thematic expansion of normative gated communities already prevalent on the mainland. He suggests these communities might constitute one of the few urbanistic consistencies in Dubai with an Islamic heritage:

“From the typical Arab house with its courtyard and degrees of privacy to the different form of mixed use complexes that exists within Arab and Islamic history - from caravanserais along the silk road to palaces such as the Alhambra and to the later kulliyes - entire closed compounds inserted within the fabric of Istanbul - the notion of a private enclosed space as a model of living and of development is very much a part of Muslim tradition, working well with its codes of being and living.” (Cities from Zero, 52)

But perhaps this is too convenient a comparison. The World Archipelago distinguishes itself from Nakheel's other developments in that its form is strategically catered towards the international community. While most island sales are undisclosed, several high profile transactions follow a similar pattern: Turkish group MNG Holding bought the Turkey Island in 2008, Chinese Zhongzhou International Holding Group recently purchased the Shanghai Island, and Sir Richard Branson of Virgin Airways is displayed prominently on Nakheel's promotional sites planting the Union Jack on the Great Britain island. In contrast, sites with less commercial appeal, such as Northern Canada, Western Australia, and all of Antarctica, are zoned as shopping districts or are being built out as resorts by the developer itself.

Nakheel has gone to great lengths to maintain the international standard of suburban life: high speed commuting into the city and an ubiquitous infusion of shopping and restaurants. Though there are conceptual remnants of the privacy of the traditional courtyard house, The World Archipelago has come to more closely resemble a Radburn-style bedroom community. In addition, the density which is suggested in renderings but never actually specified by Nakheel suggests that the vast number of people that will inhabit The World

undermines the promise of copious space and privacy in the interest of financial profit. (Cities from Zero 52)

Both Hulhumale and The World Archipelago have been burdened with dual agendas. Superficially, each is a relatively normative development, comprised of mixed market rate residential and commercial units. Fundamentally, each project addresses a different type of speculation which is related to looming environmental and economic crises. Both projects deploy a strategy of land reclamation: at all costs, the Maldives must increase their height from the water; Dubai in turn must conjure a plethora of beachfront properties with the hyperbolic flair for which the city has become known. In the Maldives, the new capital employs boulevards, central parks, and an abundance of new civic programmes to project an environment of stability found typically in mainland cities. In Dubai, Nakheel mimics the distribution pattern of a tropical archipelago in order to produce an aesthetic of novelty and luxury that will promote economic growth. New land is created not simply as territorial expansion, but it is used as an opportunity to introduce new urban typologies which compensate for the imminent shortcomings of an existing urban condition.

# Crisis & Architecture: A Convenient Fiction?

## Crisis as Discourse

Rem Koolhaas, in his keynote lecture at the Ecological Urbanism Conference at Harvard University in April 2009, identifies a bifurcation in the debate of ecological crisis. On the one hand, one camp is working with an earnest dedication to resolving discrepancies between architecture and climate, which he typifies with the proponents of tropical architecture in the late 1960s. Koolhaas identifies a contrarian camp, as well, that is less concerned with “reasonable progress” and more enamored with the battles of mankind and nature. The title of the lecture, *Sustainability: Advancement vs. Apocalypse*, aptly names these two discourses. “Advancement” represents the many architects and teachers in the 1960’s and 1970’s, including Koolhaas’ own instructors in 1968, as desperate to impart a body of knowledge in which architecture learns from the non-architectural precedents of its site, creating structures that are heated and cooled without mechanical assistance. Koolhaas summarizes their teachings as “condescending” but with a “highly efficient didactic intensity.” The latter movement, *Apocalypse*, establishes a discourse that is decidedly anti-modern, as their conversation is limited to the projection of crises rather than prevention or reaction. He quotes from Paul R. Ehrlich’s book *The Population Bomb*, who in 1968 says of world hunger that “at this late date nothing can prevent a substantial increase in the world death rate;” and from James Lovelock’s 2006 book *The Revenge of Gaia* that “by 2040, parts of the Sahara Desert will have moved into middle Europe.” Emphasis is placed on the projection of disaster, rather than the production of how it might be (or should be) prevented. Koolhaas proposes that there is yet no middle ground between these discourses, even though shared crises or evidence (recently, environmental) may create the illusion that everybody is talking about the same thing. While one group leverages this evidence towards a “rational and reasonable future,” the other is sufficiently satisfied with a future that ends in catastrophe. Koolhaas argues for greater coherence, but offers no resolution. The trouble, it would seem, is that while though one group is too deeply entrenched in the production of utopia/dystopia, the other finds itself stuck in the production of architecture that is



relevant from a technological point of view, but in its maintenance of the status quo, fails culturally.

“Invoking the “apocalypse” brings forth connotations of the end of the world - historically imagined as everything from the judgment of God to nuclear Armageddon. In its contemporary manifestation it has taken the form of various global crises; whether environmental, economic, or the unexpected. Of course the “end of the world” is not a novelty; it has its own history and is itself a genre of expression as a category of pessimism. A recurrent theme, it is the shadow of the progressive ideal of the avant garde.” - John McMorrough, *Design for the Apocalypse*, Thresholds 35

In his essay “Design for the Apocalypse” (Thresholds 35), John McMorrough positions crisis not as an end, but as a new beginning, a fresh start. “In this sense the specter of the apocalypse is another version of the modernist tabula rasa, a leveling of the past to make way for the future.” Crisis becomes an opportunity to rethink the mode in which we produce architecture, a recalibration of our “historically formulated set of rules and guidelines,” but also a chance to design towards a new set of constraints, such as food, water, and capital. McMorrough contrasts design for the apocalypse with design for the utopia, highlighting a fundamental shift towards an architecture of scarcity from an architecture of plenitude. Both scenarios project radical futures, in which architecture must make manifest a cultural forecast: does apocalypse initiate the Utopian condition, recalibrating architecture to exist within a radicalized environment, or will the apocalypse subvert it, creating a utopia which is positioned in opposition to threats current and future?

Bruce Mau introduces his 2004 publication *Massive Change* with a quote by English historian Arnold J. Toynbee, who was awarded the Nobel Prize in 1957. In his acceptance speech, Toynbee states “The twentieth century will be

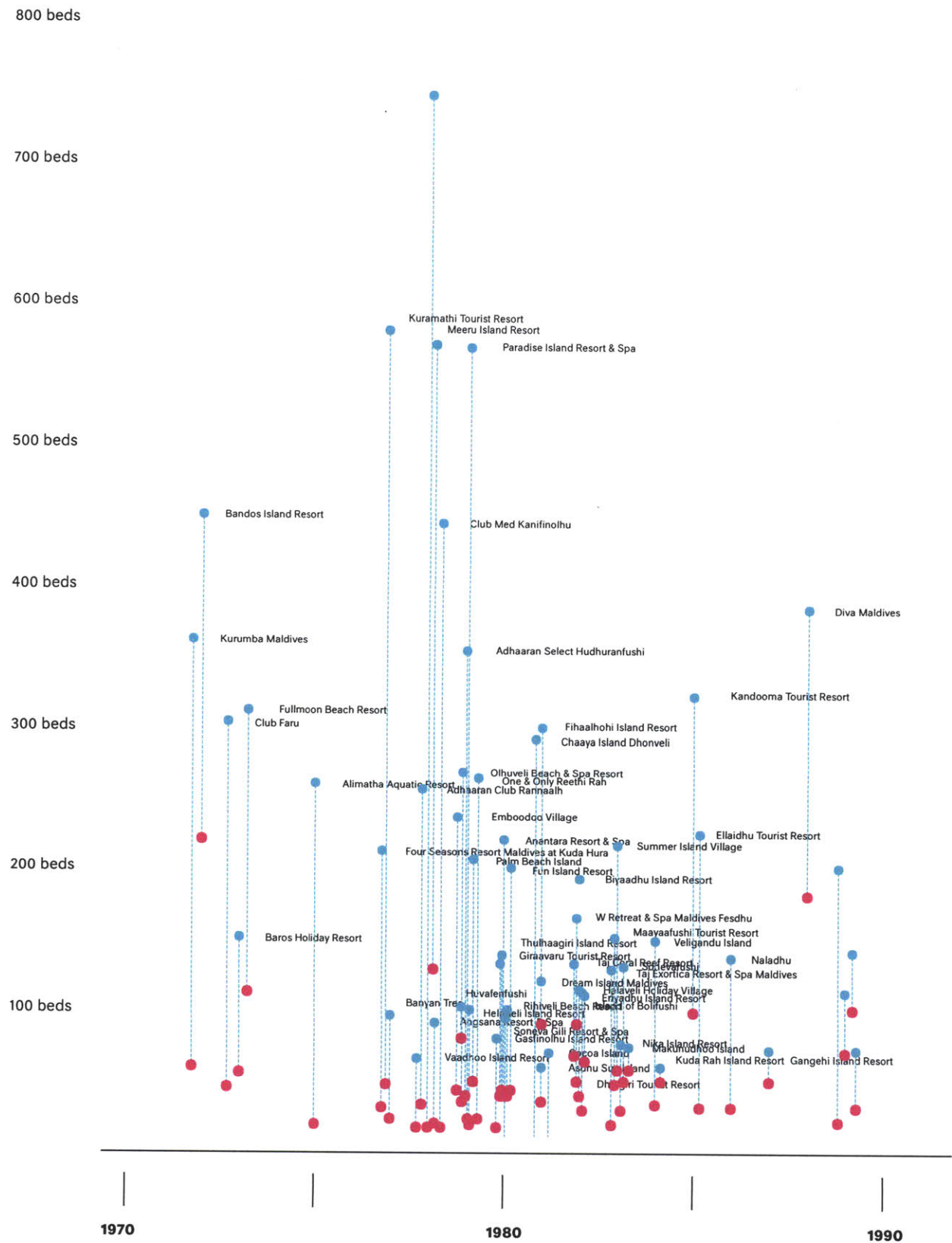
chiefly remembered by future generations not as an era of political conflicts or technical inventions, but as an age in which human society dared to think of the welfare of the whole human race as a practical objective.” Mau attributes this quote to a shift in his own perception, whereby designers are no longer in pursuit of the Utopia, but are justified in pursuing practical objectives. Mau submits that “when systems fail we become temporarily conscious of the extraordinary force and power of design, and the effects that it generates. Every accident provides a brief moment of awareness of real life, what is actually happening, and our dependence on the underlying systems of design.” His own interpretation of the discourse is that design will no longer be defined by socio-political orientations, but simply by Advanced vs Retrograde, each of which embrace opportunities from “advanced capitalism, advanced socialism, and advanced globalization.”

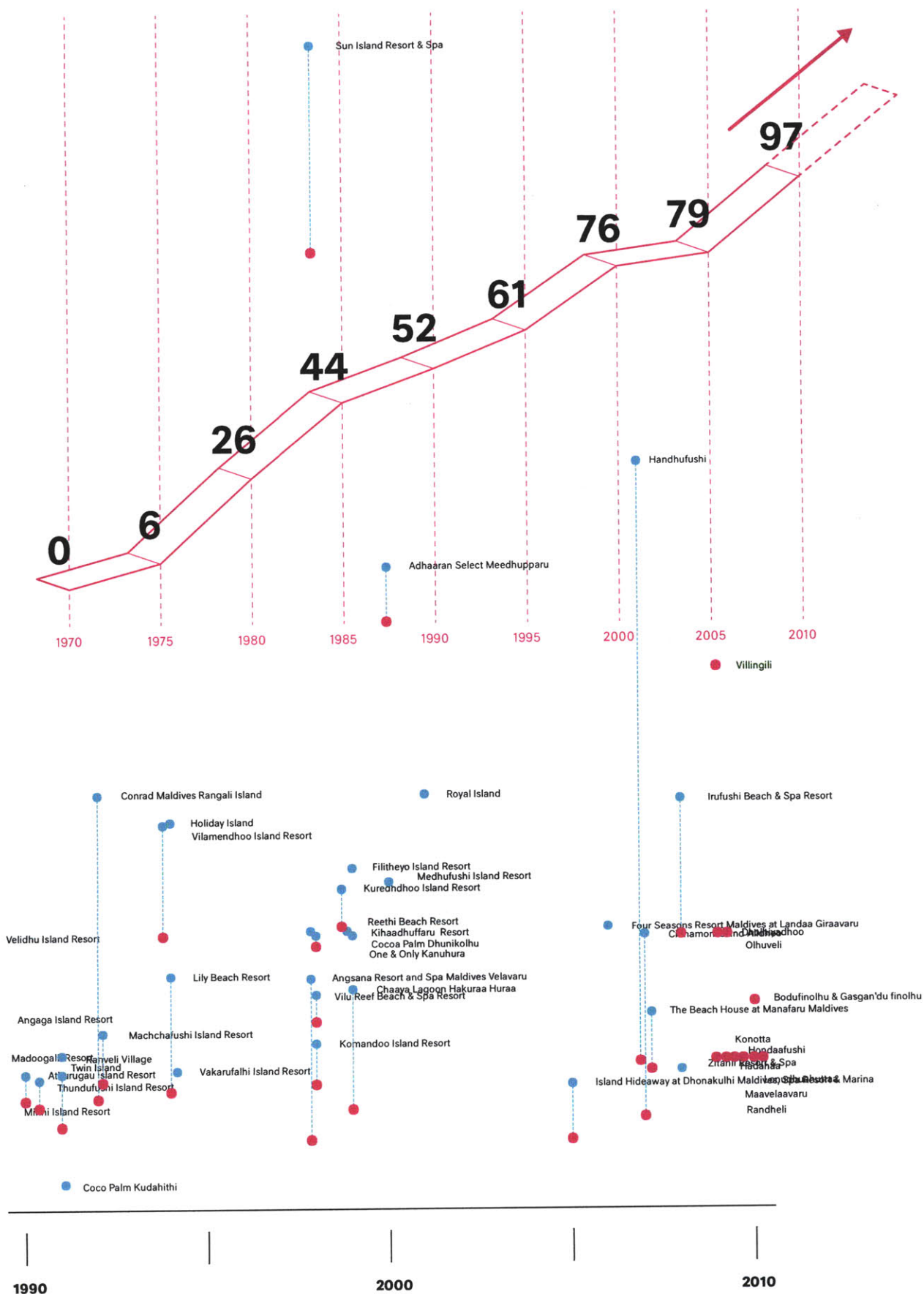
Perhaps then Koolhaas’s “Advancement” and “Apocalypse” discourses are best synthesized under the umbrella of radicalization, engaging the fervor surrounding those who are anxious to propose ‘solutions,’ but within the parameters of radically changed futures. Crisis is a truly broad term: catastrophe takes form in the guise of earthquake, tsunami, financial meltdown, forest fire, climate change, war, and other possibilities yet unimagined. Architectural projects dealing with crisis appear to break down into two categories, though the line between them is at times indistinct: essentially, one can deal with a crisis before it occurs, or after. This is not entirely divergent from Koolhaas’s categorization of Apocalypse vs. Advancement, but it is a way of sorting interventions into those projects that attempt to fix the past, and those that try to reevaluate the future.



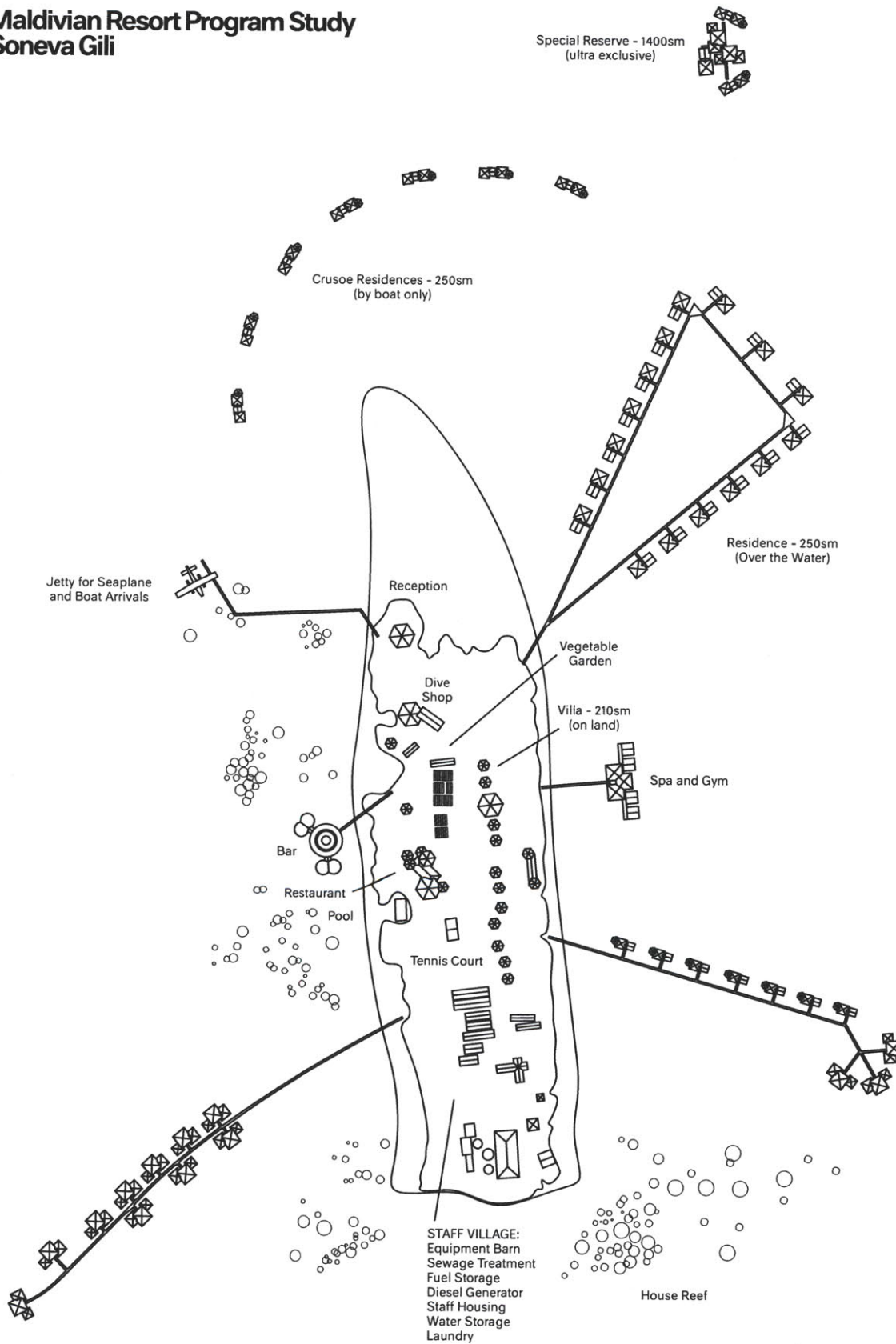


# Proliferation of Resorts in the Maldives

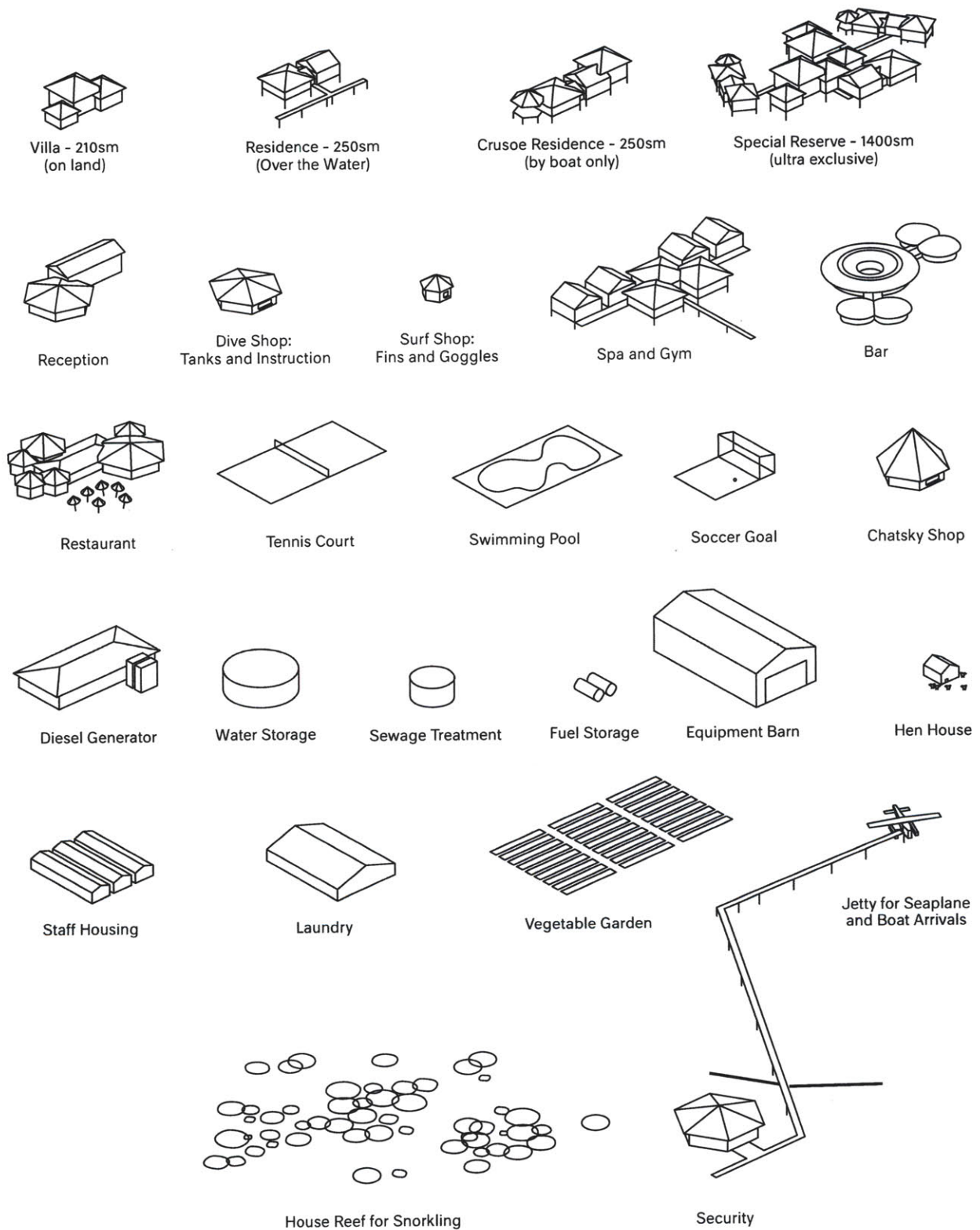




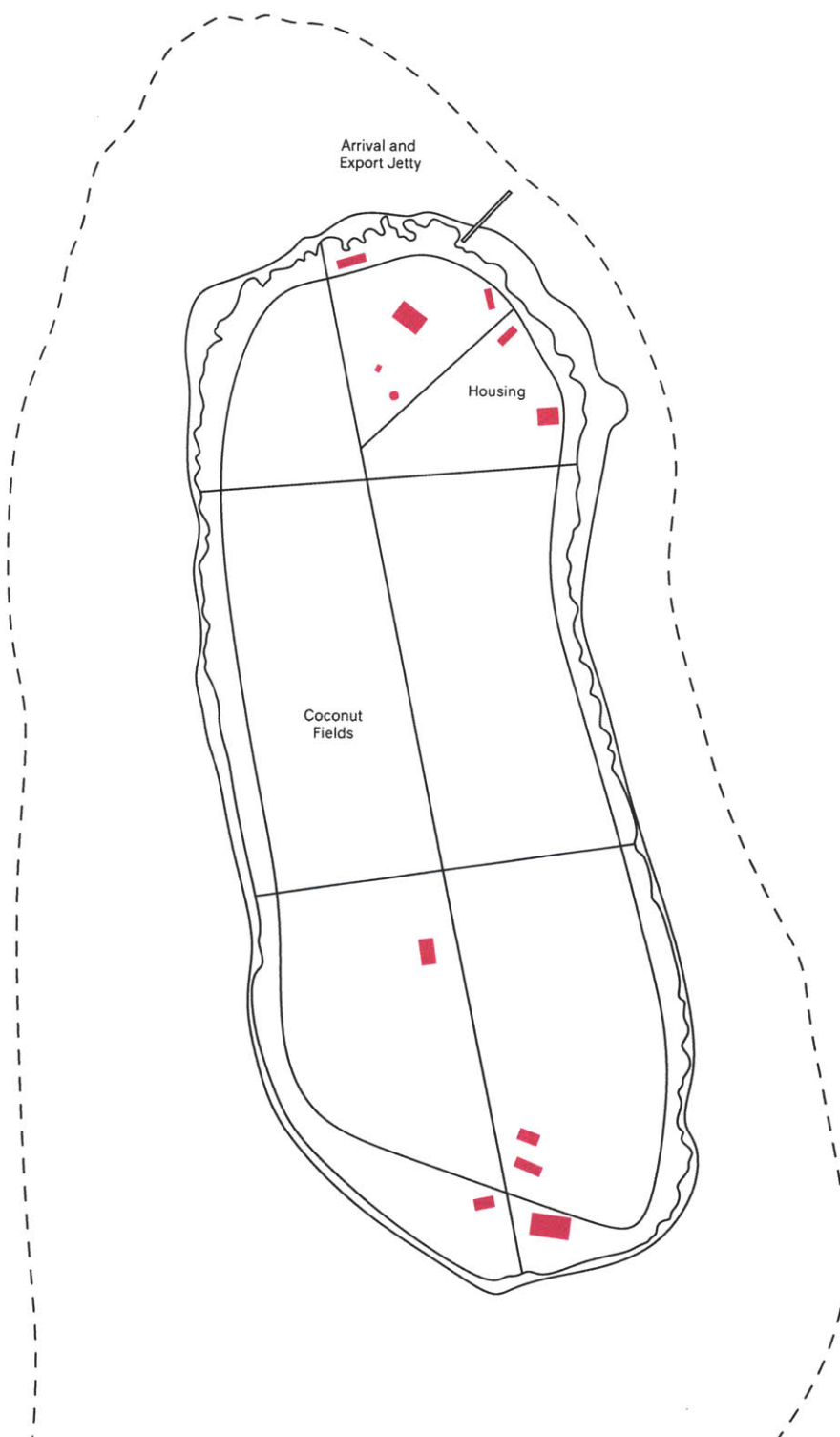
# Maldivian Resort Program Study Soneva Gili

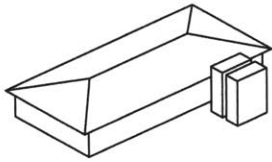




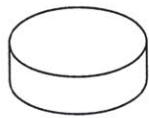


## Maldivian Farm Island Study Maamalgili





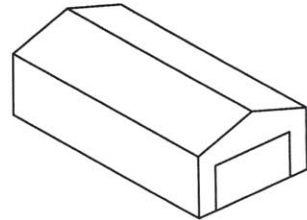
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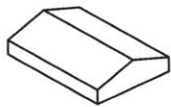
Water Storage



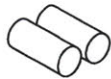
Hen House



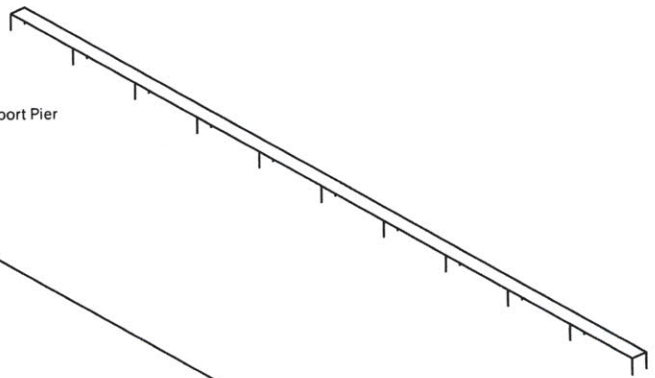
Equipment Barn



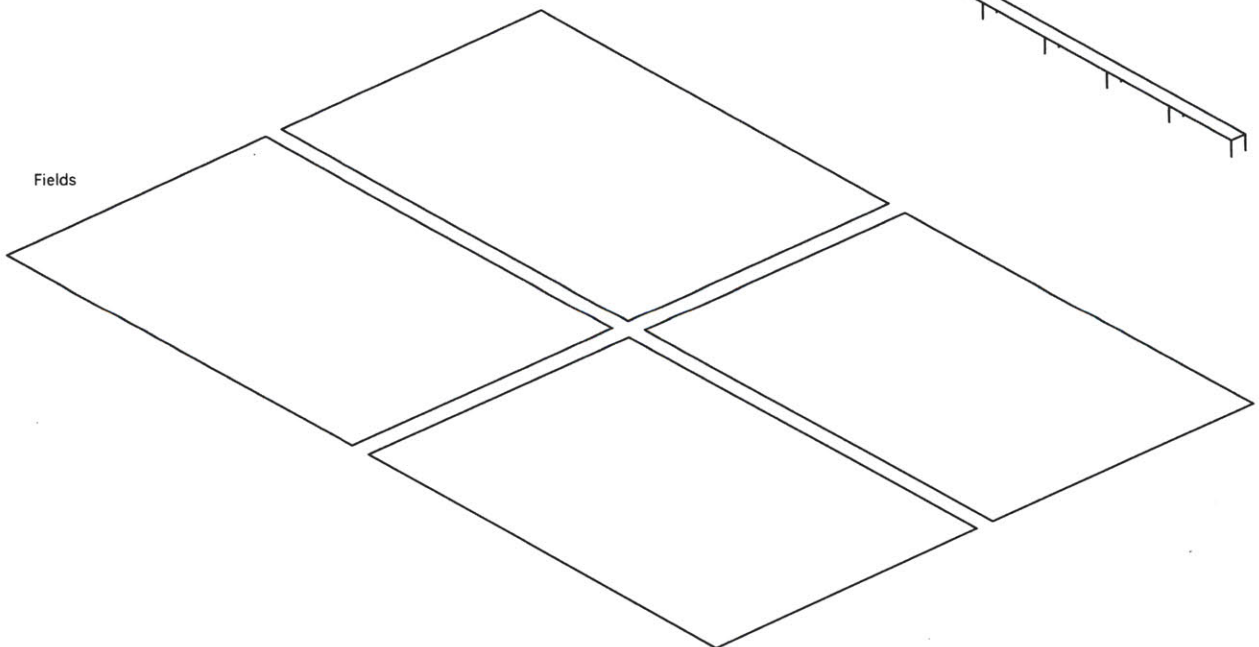
Housing



Fuel Storage



Export Pier

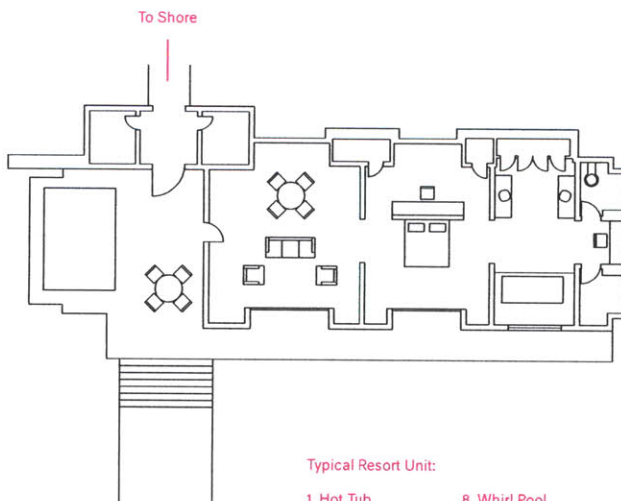
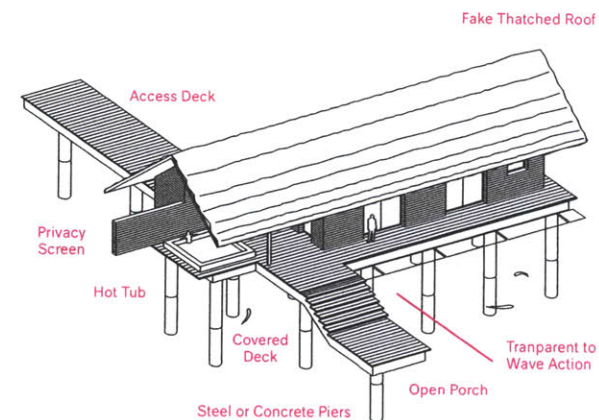


Fields



## Typical Housing Precedents

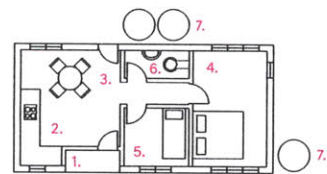
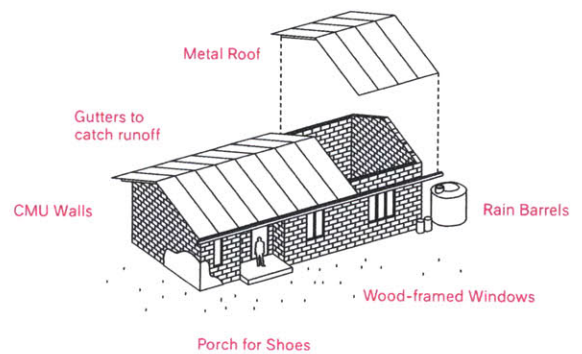
### Resort Bungalow One and Only Resort \$1700/night



Typical Resort Unit:

- |                 |                   |
|-----------------|-------------------|
| 1. Hot Tub      | 8. Whirl Pool     |
| 2. Covered Deck | 9. Shower         |
| 3. Open Porch   | 10. Dressing Room |
| 4. Living Room  | 11. Vanity        |
| 5. Dining Room  | 12. Toilet        |
| 6. Bedroom      | 13. Closet        |
| 7. Office       | 14. Storage       |

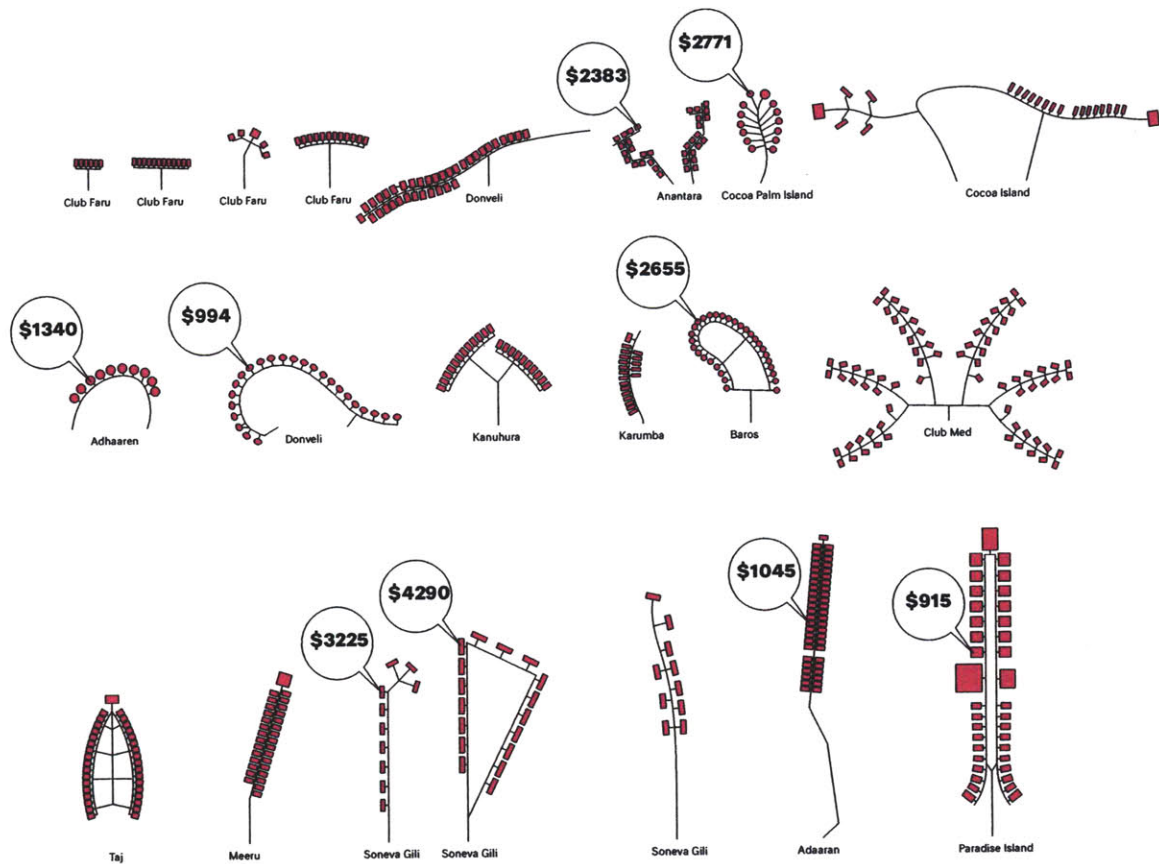
### Maldivian House Guraidhoo \$32/night



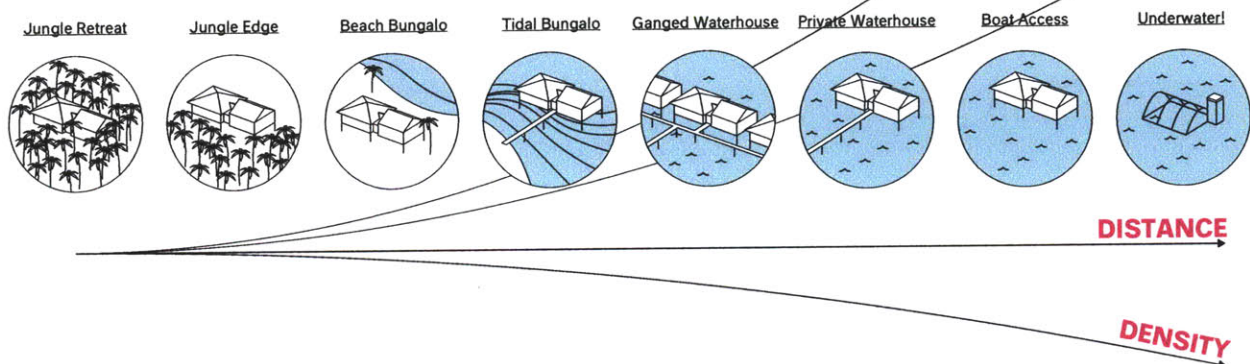
Maldivian House Program:

1. Porch for Shoes
2. Kitchen
3. Dining
4. Bedroom
5. Study/Bedroom
6. Bathroom
7. Rain Barrels

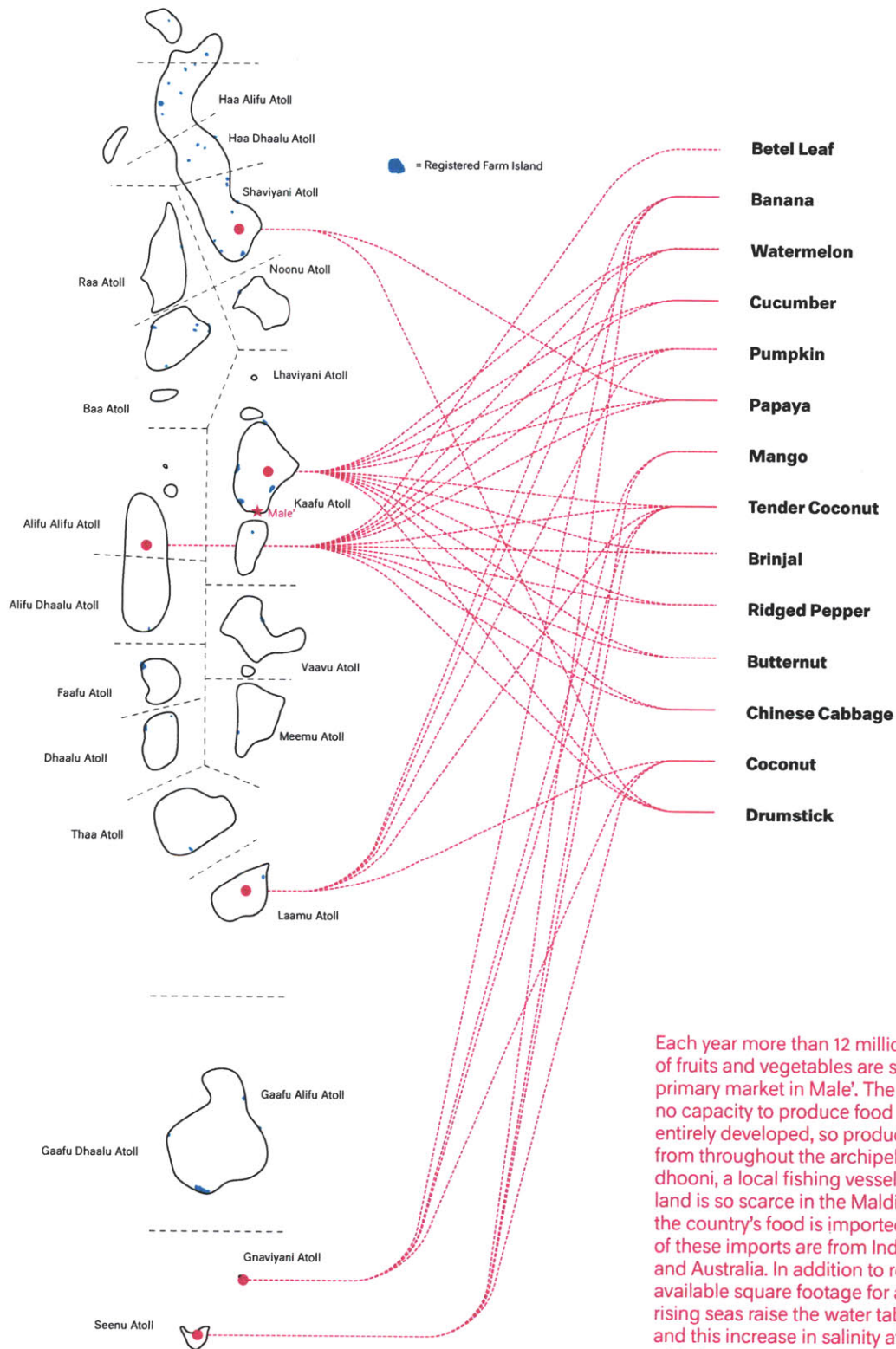
## Over-the-Water Guest Piers



## Bungalow Types

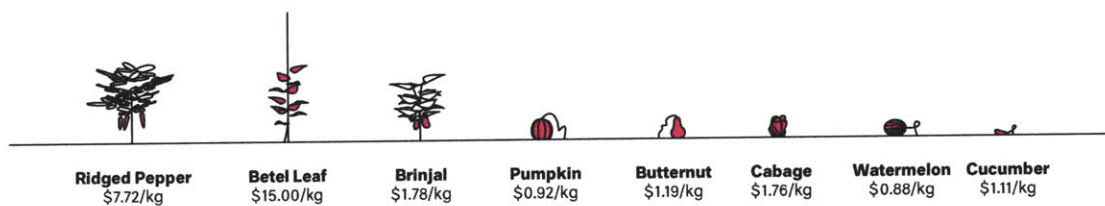
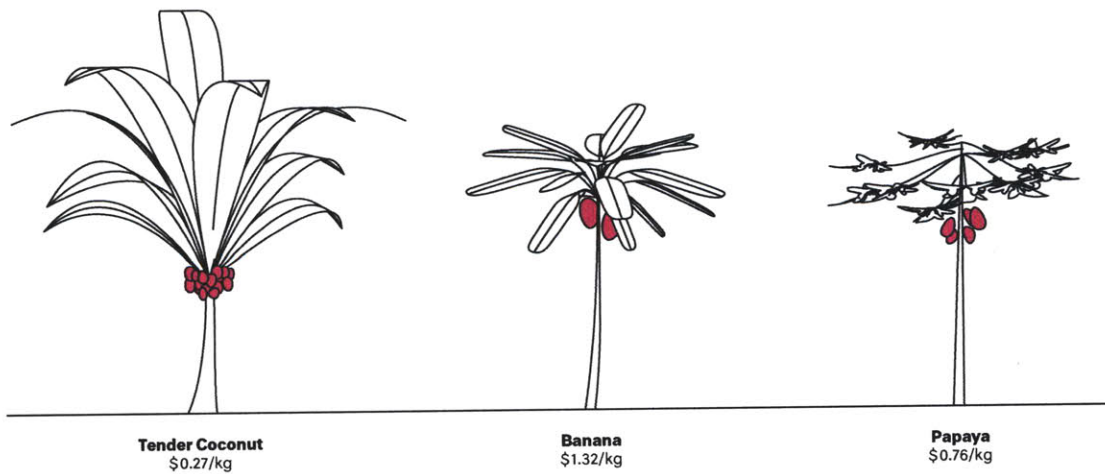
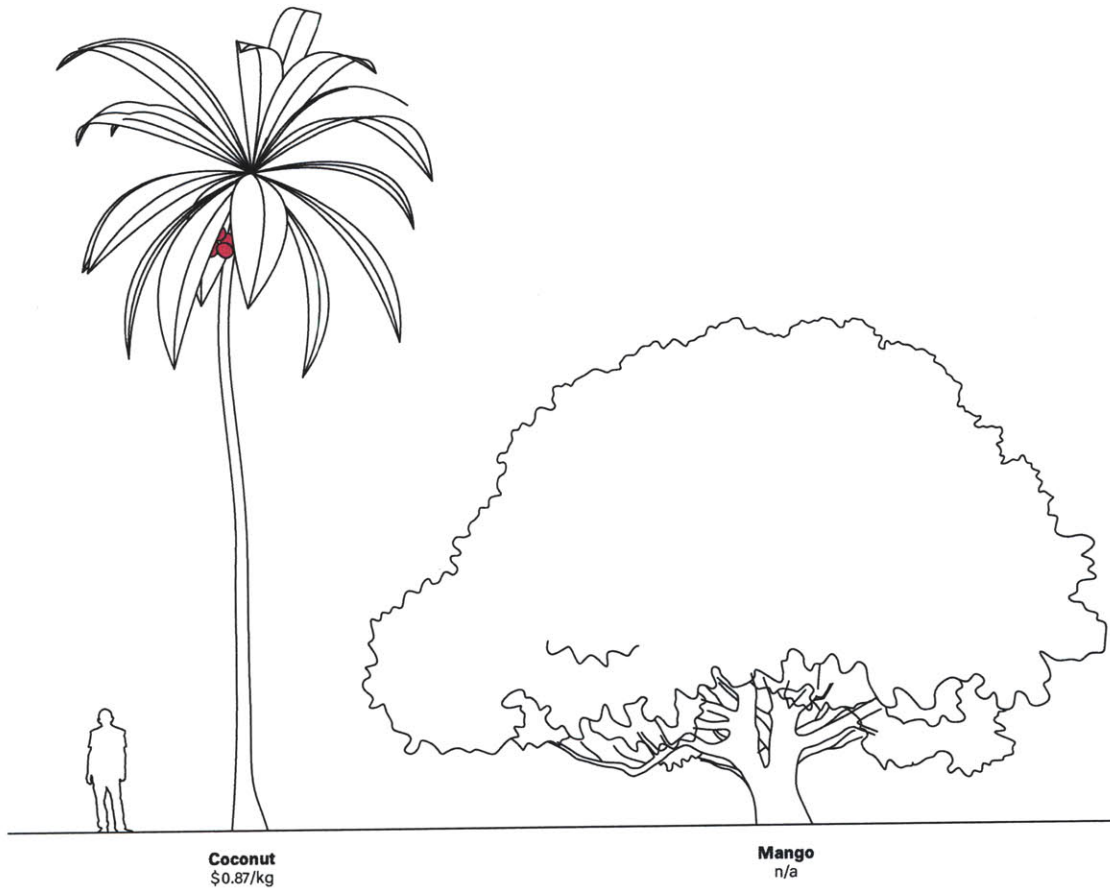


## Agricultural Production

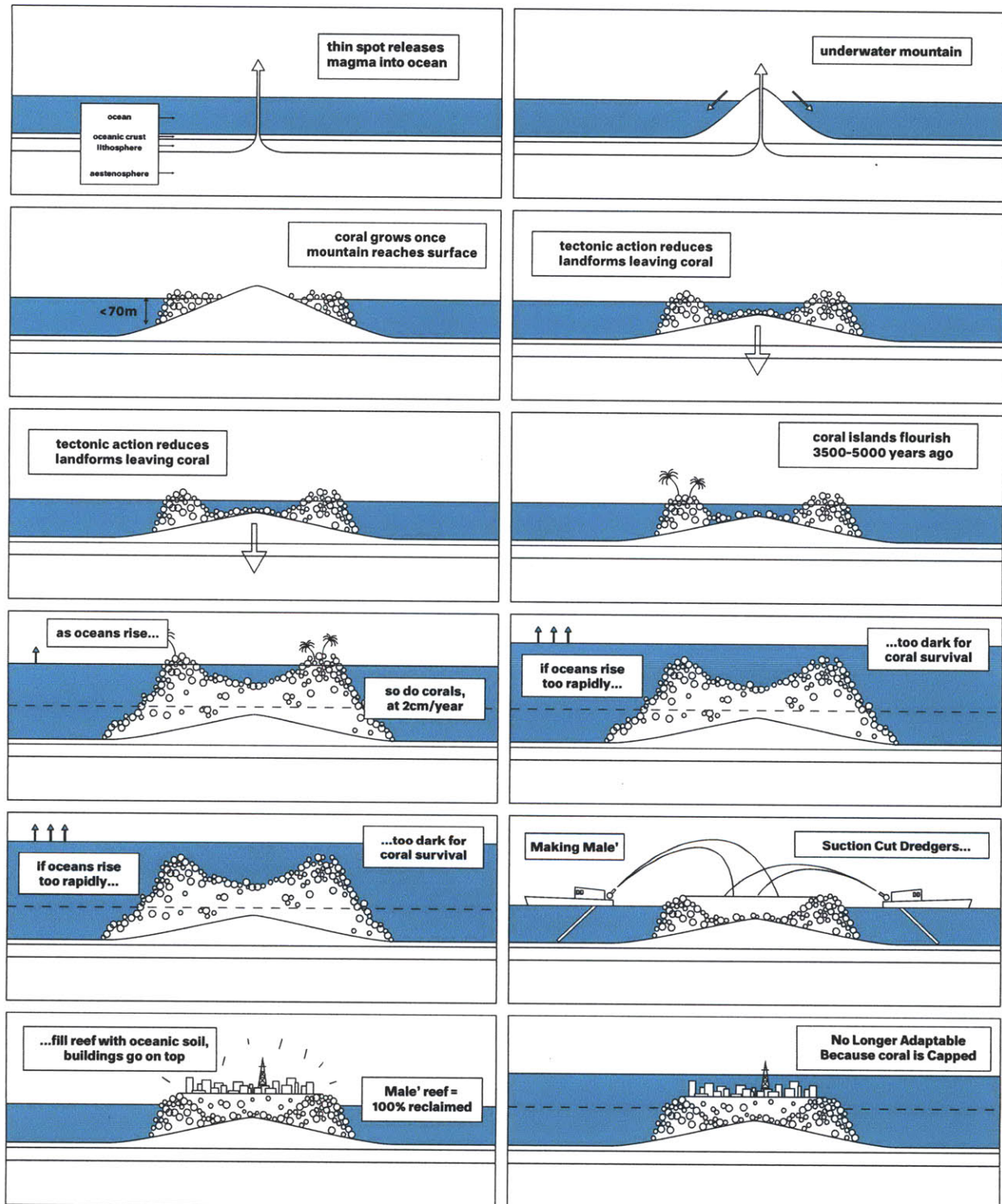


Each year more than 12 million dollars of fruits and vegetables are sold at the primary market in Male'. The capital has no capacity to produce food itself as it is entirely developed, so product is imported from throughout the archipelago by dhooni, a local fishing vessel. Because land is so scarce in the Maldives, 93% of the country's food is imported. The majority of these imports are from India, China, and Australia. In addition to reducing the available square footage for agriculture, rising seas raise the water table on island, and this increase in salinity affects plants with deeper root systems. Mangos, for example, will no longer grow on Male' because the soil is too high in salt.



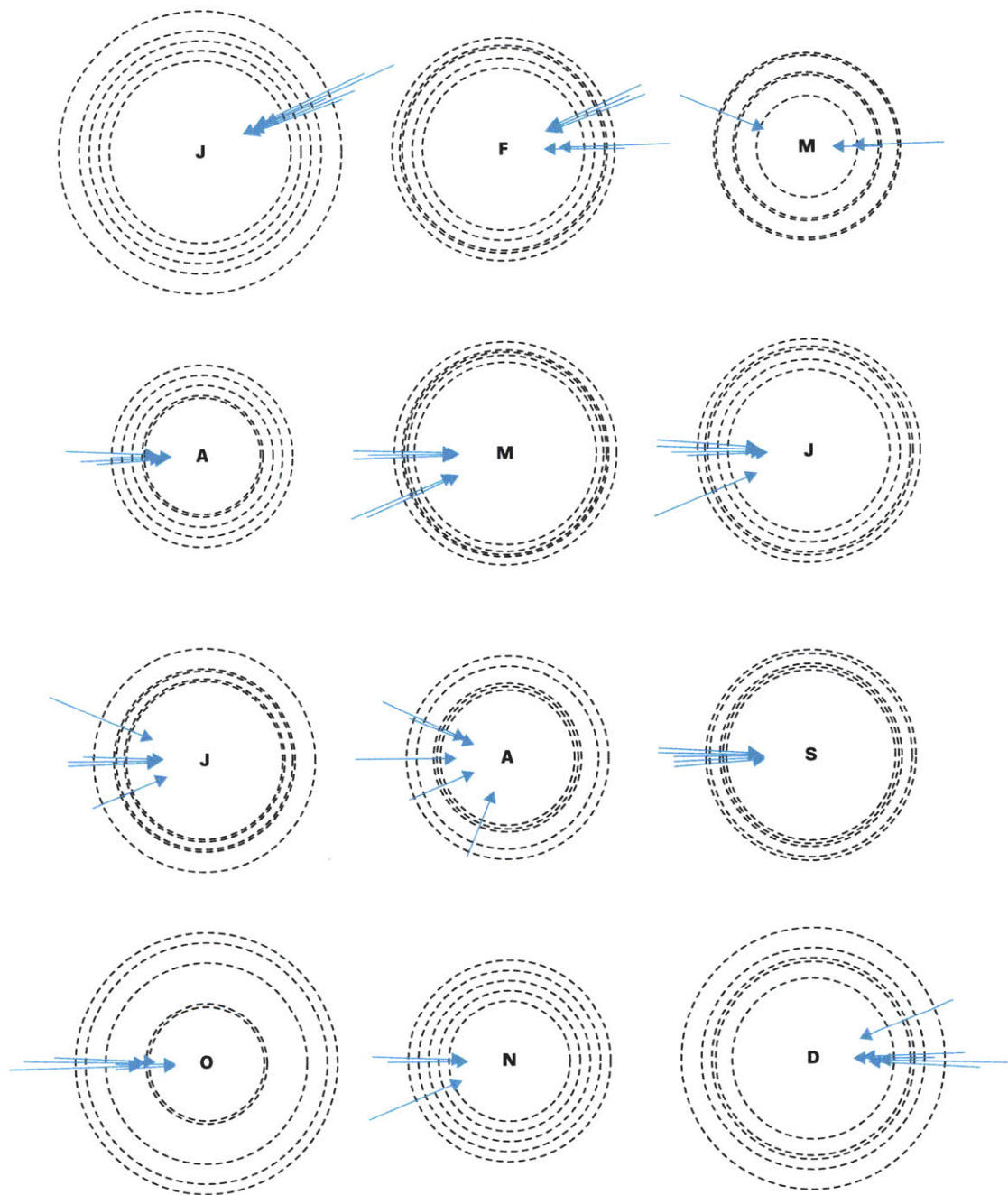


## Formation of Atolls

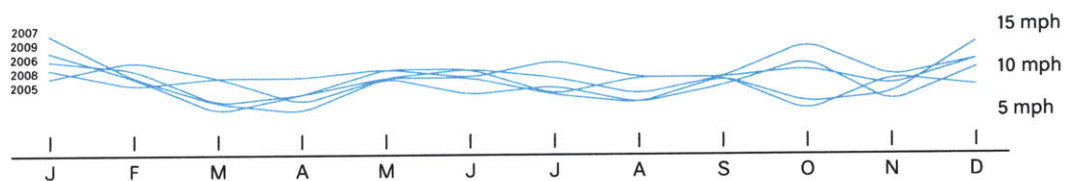


The 1,190 islands and countless submerged reefs of the Maldives are the product of tectonic action and the upward growth of corals. Although one common held belief states that as sea levels rise the islands will rise with them, the corals that have historically provided this adaptability are in crisis: either they have been fished or filled to extinction, or they lie bleached and dying due to increased ocean temperatures that kill the algae necessary for photosynthesis. Furthermore, existing buildings will not rise with the reefs without intervention.

## Annual Monsoon Behavior

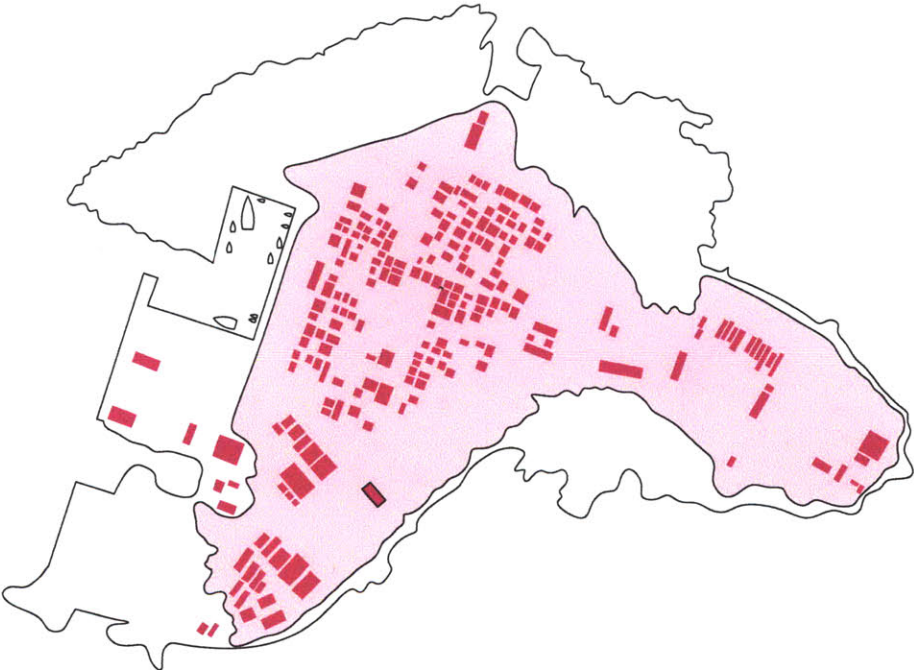


**Wind Direction and Strength**  
 Arrows indicate direction, circles indicate strength. By month, 2005-2009

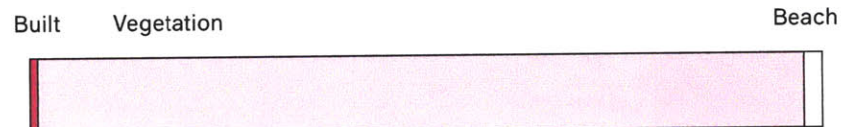
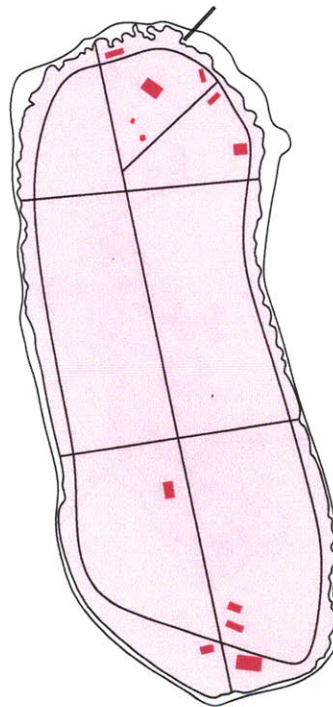




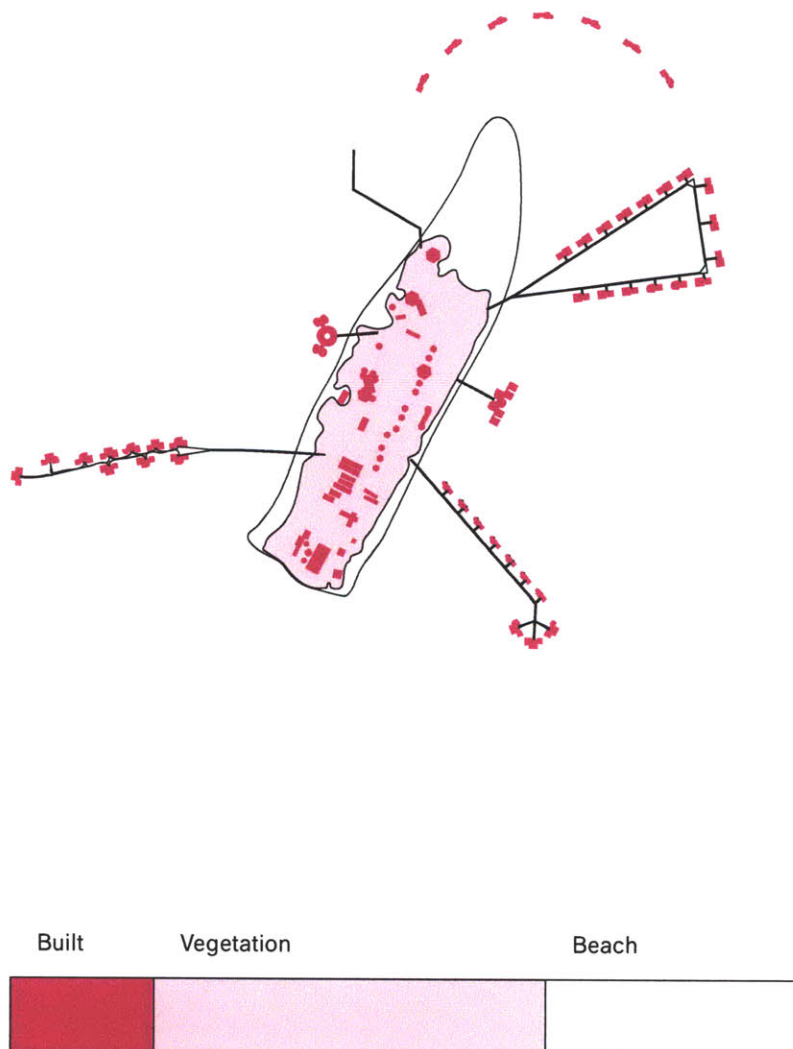
**Himmafushi: Inhabited Island**



## Maamalgili: Farm Island

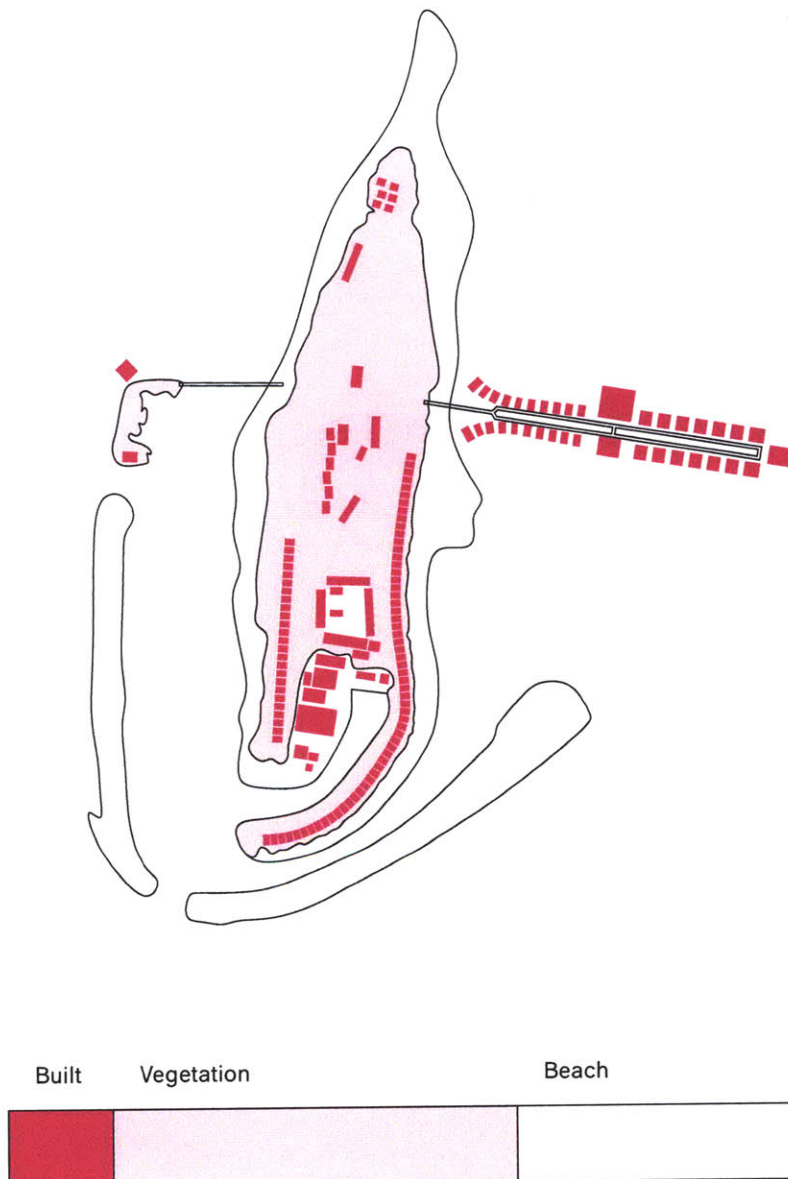


## Soneva Gili: Resort

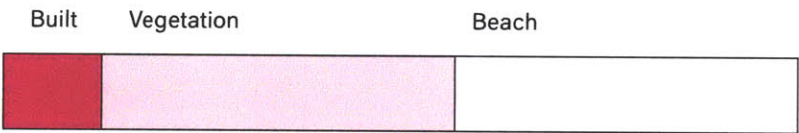
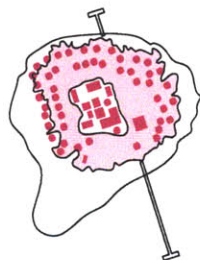




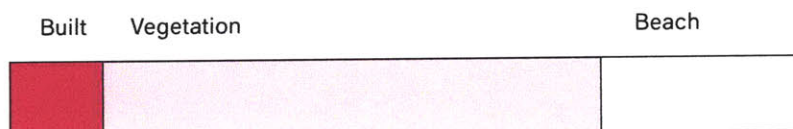
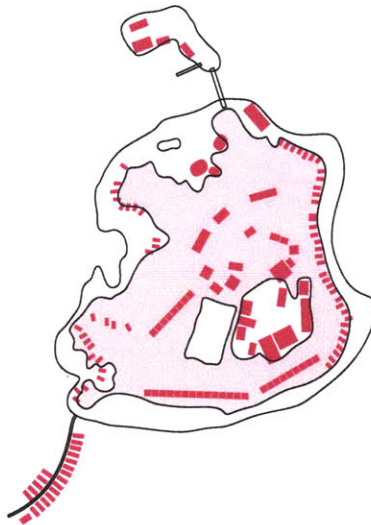
## Paradise Island: Resort



**Banyan Island: Resort**

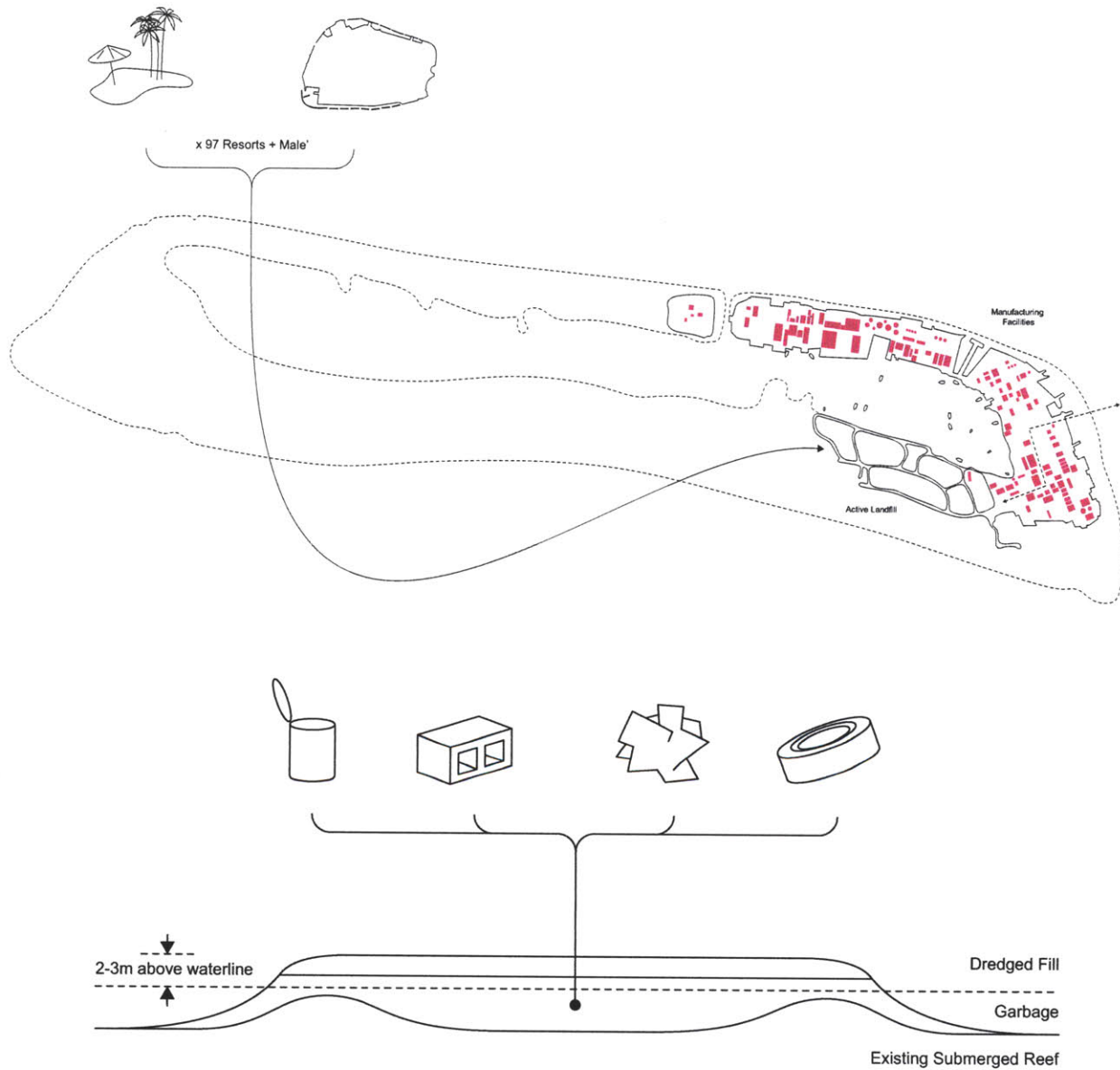


## Holiday Inn: Resort



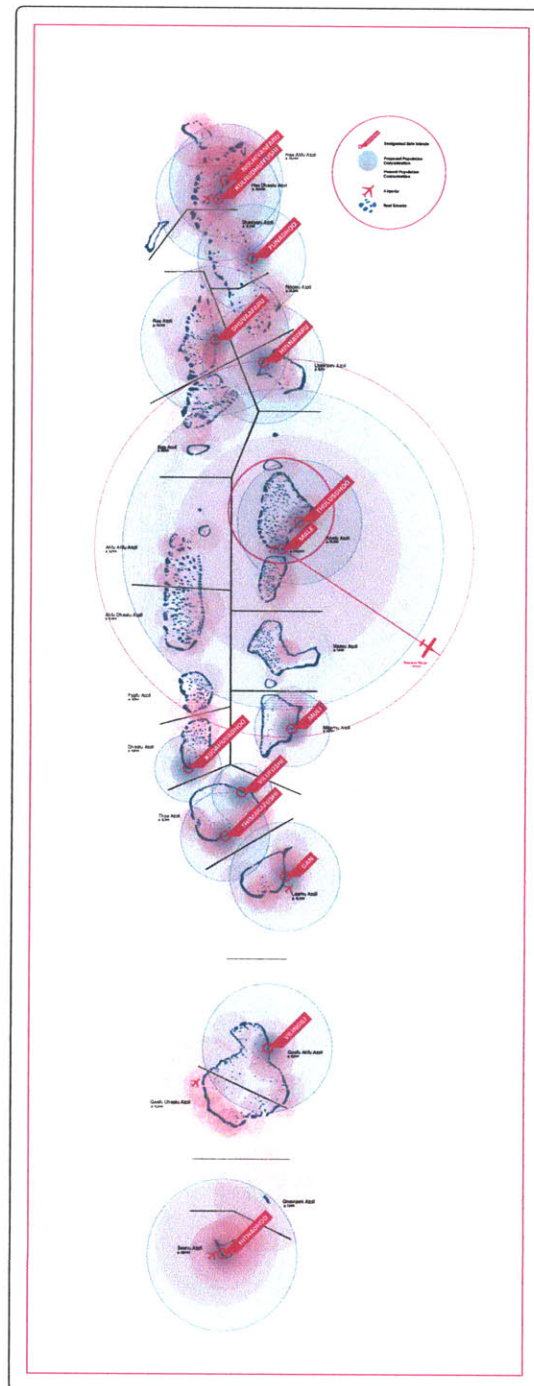


## Thilafushi: Trash Island



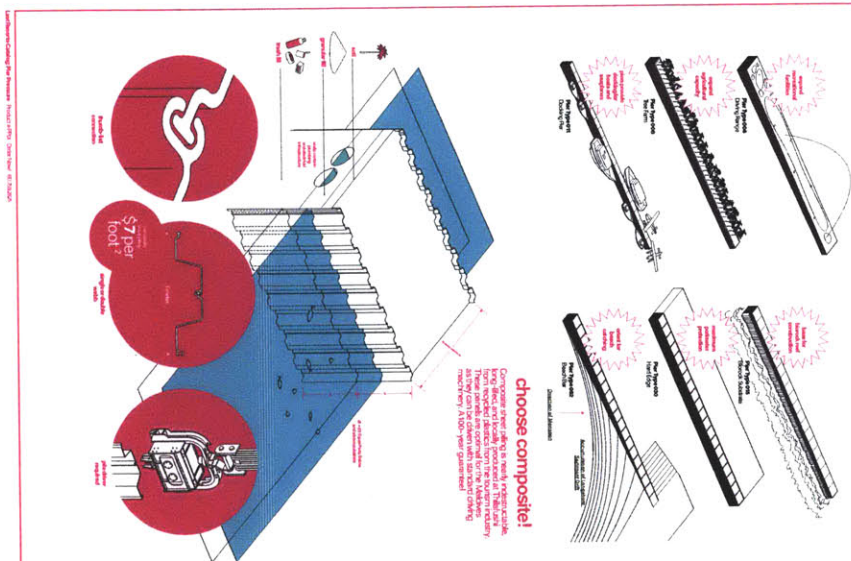
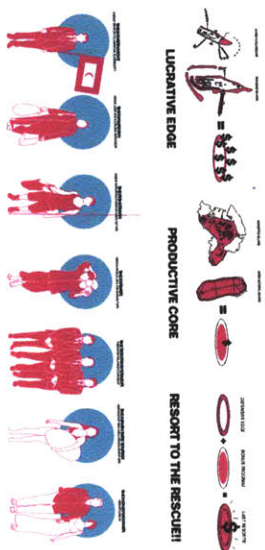
## Male': Capital Island





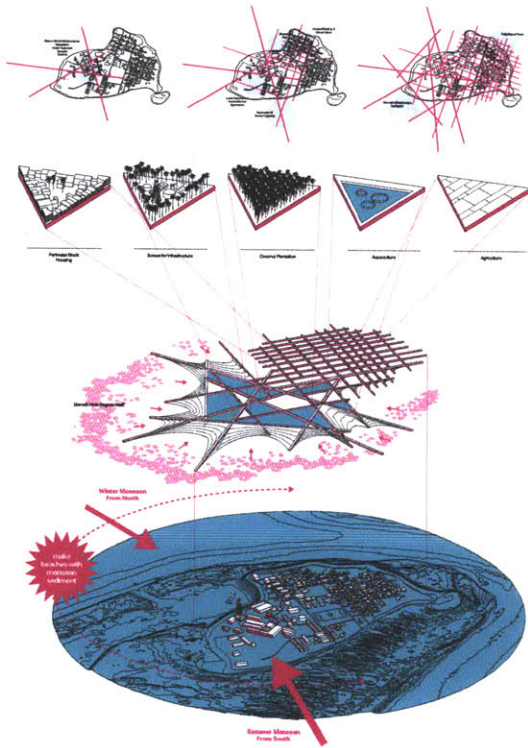


## PIER PRESSURE

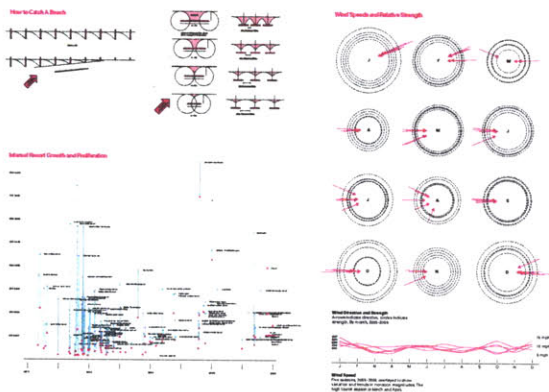


## BEACH BUILDERS

no more fussy dredging!

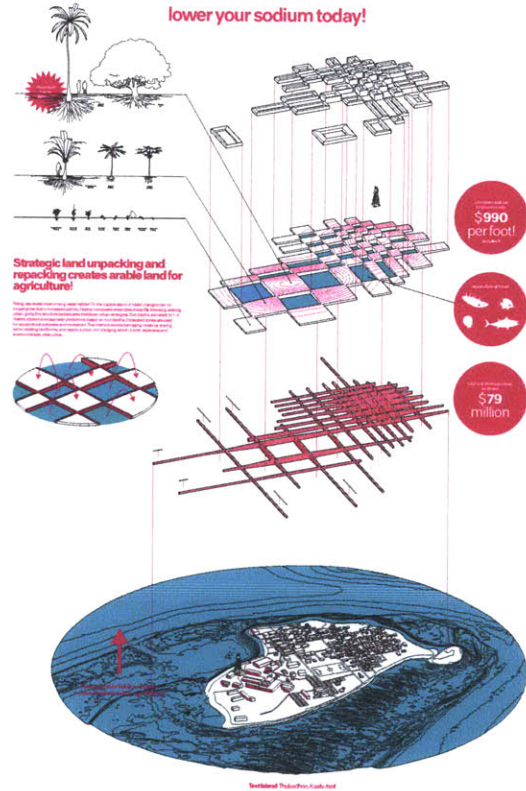


Land Reclamation Using Beach Builders Product © 2010, Daniel Heuer AG, Hamburg

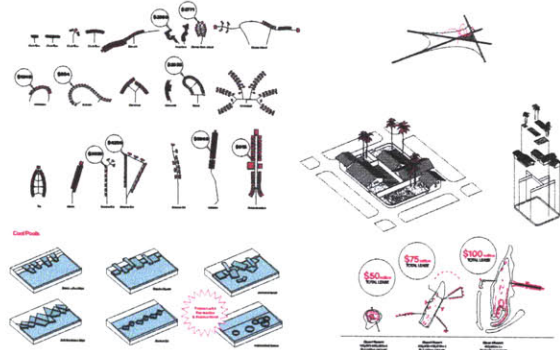


## POTTED PALMS

lower your sodium today!



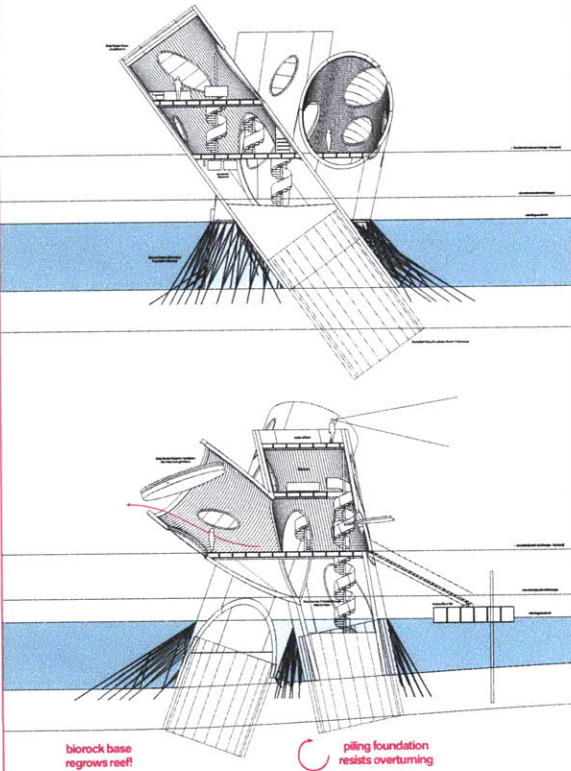
Land Reclamation Using Potted Palms Product © 2010, Daniel Heuer AG, Hamburg



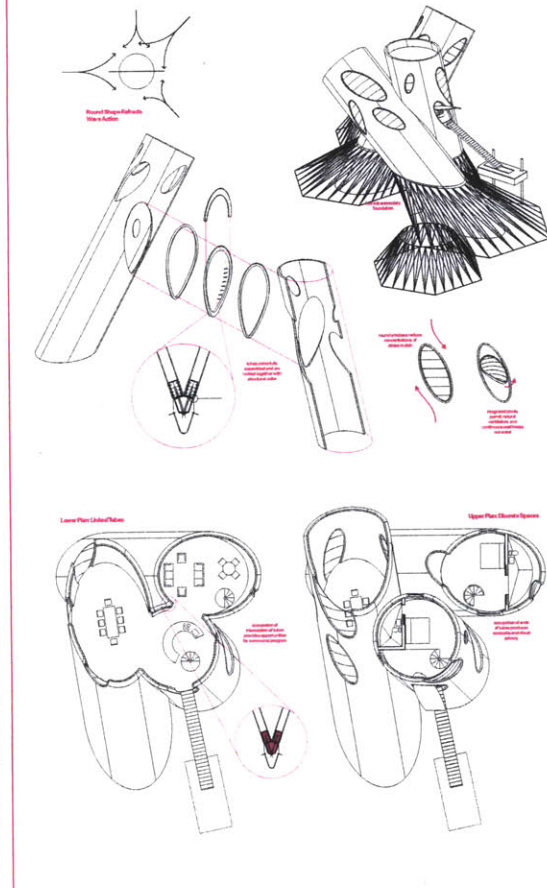
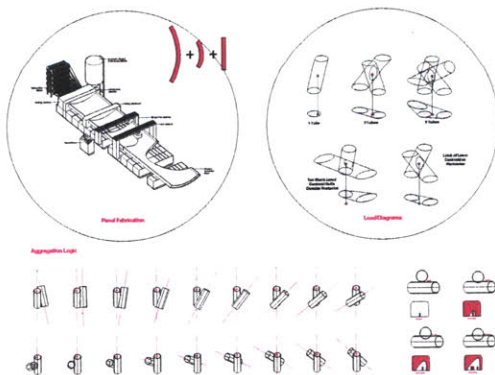


# BREAKWATER BUNGALOW

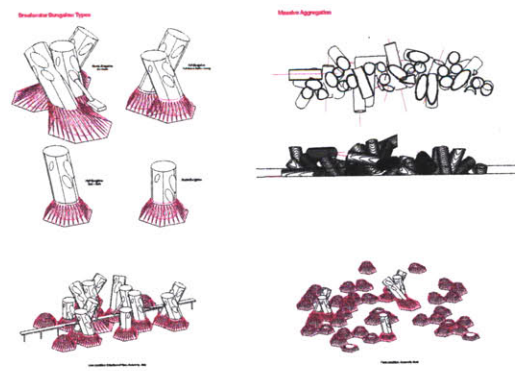
break waves, make reefs!



LeafHouse/Casting Breakwater Bungalow Product #1001 Color Year #17/10/2010



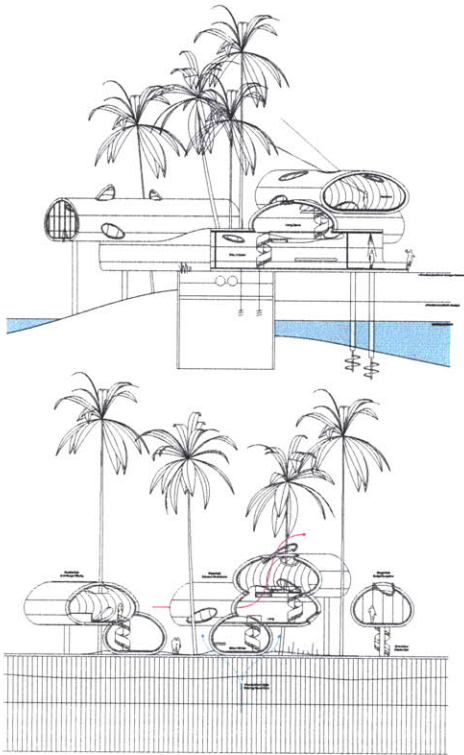
LeafHouse/Casting Breakwater Bungalow Product #1001 Color Year #17/10/2010





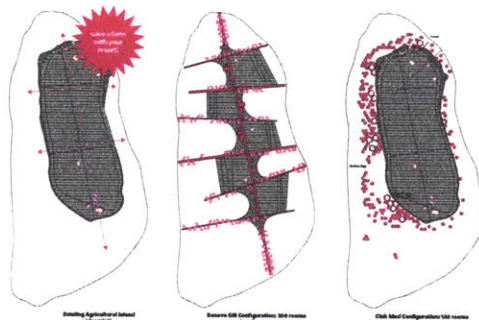
**Final Thesis Defense:  
December 13, 2010**

## WET/DRY VILLA



Last Resorts/Building: Wet/Dry Villa Product # 857000 Color: Pearl # 857000-001

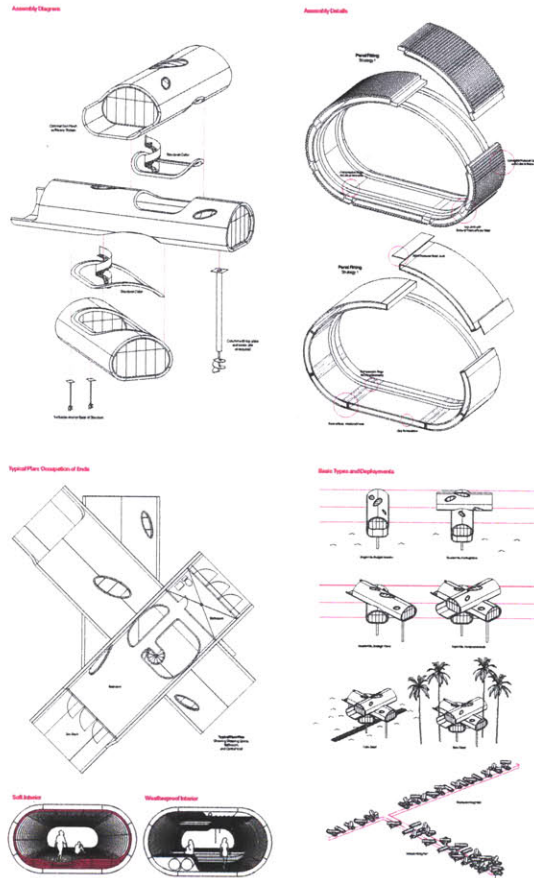
### Application and Foundation



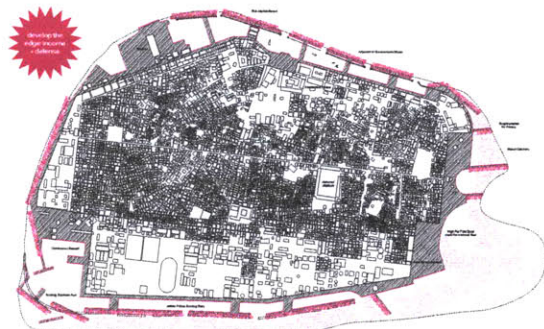
Existing Application of Island

Existing Application of Island

Existing Application of Island

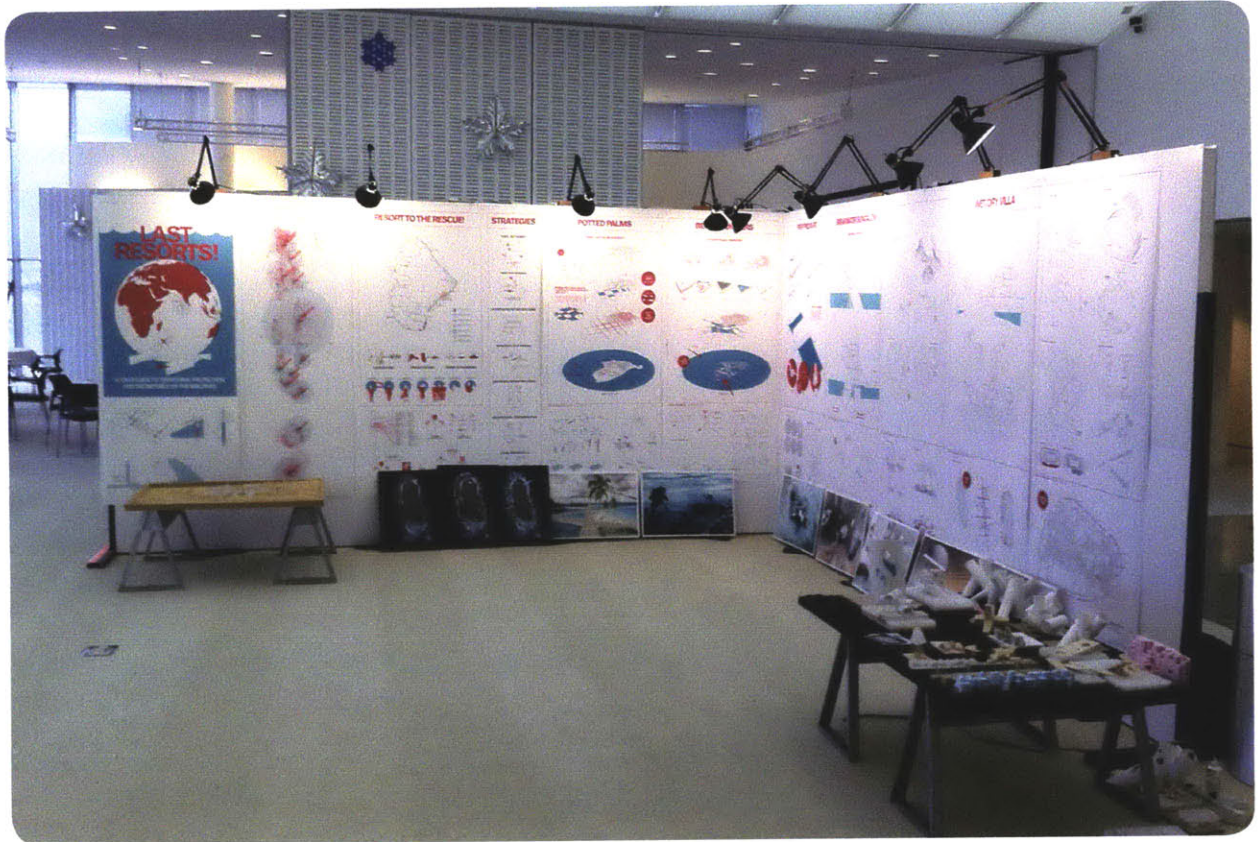


Last Resorts/Building: Wet/Dry Villa Product # 857000 Color: Pearl # 857000-001



Model Configuration: 850-850 Villa  
1.5m x 1.5m x 1.5m  
20.0m x 20.0m  
850-850 Villa (850-850 Villa)





The following images are a selection from a photographic project completed during the summer of 2010 with the support of the Schlossman Foundation and the Kohn Penderson Fox Traveling Fellowship. The project proposed a photographic survey of coastal and near-coastal conditions in four vulnerable regions engaged with the production or protection of land: the Maldives, Dubai, The Netherlands, and New Orleans.

# Maldives



Vilingili, the closest inhabited island to Male', is a popular tourist destination for precisely this view. This small island housed one of the country's first resorts (now abandoned) and now houses some 7,000 people. Facilitated by a regular ferry back to the capital, it is considered one of Male's five neighborhoods.







A worker from Bangladesh guards a construction shed on the island of Guiraidhoo, a small island 30 kilometers from Male'. Although nearly finished, construction has stopped on the 118' wooden safari vessel inside due to lack of funding. I returned several times to photograph the boat and its stalwart custodian.



Two young men sort and sell scrap metal on Male'. Because the Maldives lacks the facilities to recycle and fabricate most industrial materials, discarded construction materials reclaimed and sold on the street. Recycling is otherwise sent to India for processing.







Although the most abundant material in the Maldives is sand, there is a ban on dredging and coral mining to avoid further environmental decline. This sand is likely imported from rivers in China and India, and will be used for the construction of buildings and sea walls.



On Guraidhoo, stalled tsunami-relief housing slowly fills up with wind blown debris. Throughout the village of 1500, a number of these roofless structures can be found. Although the government has designated 14 "tsunami proof" islands throughout the archipelago, it lacks the financial capacity to properly build or maintain a defensive infrastructure.







Only 20 minutes away from the congestion of Male', the artificial island of Hulhumale quietly awaits a future city. Dredged from the nearby seabed in 2004, this island is intended to replace Male' in the case of total inundation from rising sea levels. In the meantime, it provides a bizarre counterpoint and release valve to the overcrowded capital.



Thilafushi is perhaps one of the only Maldivian islands you won't see in a tour guide. Since 1992, all trash from the nearby capital island and each of the 97 resort islands has been collected and localized onto this once-submerged reef, producing an entirely artificial landscape. Trash is piled outwards rather than upwards, and industrial buildings for manufacturing and natural gas storage follow quickly behind the leading edge.







In a country where the maximum elevation is less than two meters, piles of trash at Thilafushi produce the nation's primary topographic features.



The harbor of Thilafushi underscores one of the largest social and environmental issues: too much trash. Although trash from Male' and the resorts are sent to a landfill, the majority of trash in the country is dumped at sea.







Daily flooding on Male'.



In 1987, rogue tidal waves hit the southern coast of Male', flooding half the city. In response, the government of Japan gifted the Maldives a two-kilometer wall of tetrapods in 1988. This lone unit commemorates this event.







Near the commercial port on Male', workers position steel sheet piles, which are then backfilled with trash and construction debris to form a wide breakwater.



The commercial port on Male' is only large enough to offload a single container ship at a time. As a result, the shipping channel to the north of the island is full of vessels, many who will wait weeks before unloading.







Near the fish and vegetable market on Male', workers fill storerooms with deliveries from the outer islands. Many farmers travel as far as three days by boat to deliver fresh produce to the capital, and so each inhabited island is given a storeroom near the port from which to sell their goods. Here the streets are flooded from the afternoon rains.



Blue chairs and lost underwear on Vilingili.







Before breakfast, a man from Guraidhoo wades out onto the reef to fish with a line and styrofoam box. Most fish caught in the Maldives is consumed by the locals or sold to the nearby resorts. Although fish is the primary source of protein, 93 percent of food must be imported.



From the channel between North Kaafu Atoll and South Kaafu, the concrete jungle of Male' rises quietly above the horizon. With 100,000 people living on two square kilometers, Male' is twice as dense as Manhattan, and contains nearly one third of the nation's population.



# Dubai



A thick haze hangs over Dubai, viewed from the observation deck of the Burj Khalifa. In the upper left, The World Islands await development 4 miles off shore.







On the central road of the Palm Jumeirah. This single development alone doubled the shoreline of Dubai, adding thousands of private residences, apartment buildings, and hotels. With the exception of the furthestmost edge, this shore is entirely privatized.



Imported stone armoring on the Palm Jumeirah, protecting land reclaimed from the shallow Persian Gulf.







Water delivery to the Atlantis Hotel, in the center, on the Jumeirah.



Bathing at sunset on constructed beaches beneath the Dubai skyline.



# The Netherlands



One of two massive arms, each the size of the Eiffel Tower. In the event of a storm surge, the basins in which these arms sit will flood, allowing the structure to be rotated into the canal where it sinks again to form a seal, closing off Rotterdam from the North Sea.







A man on his lunch hour, surveying the canal inland of the Maeslant Barrier.



The ubiquitous Dutch polder, and cows.







Experimental houseboats on the constructed island of IJburg, east of Amsterdam.



Floating flower markets, ever cheerful, along the canals in the historic section of Amsterdam.



# New Orleans



A level guage in the Mississippi River and oil refinery, north of New Orleans.

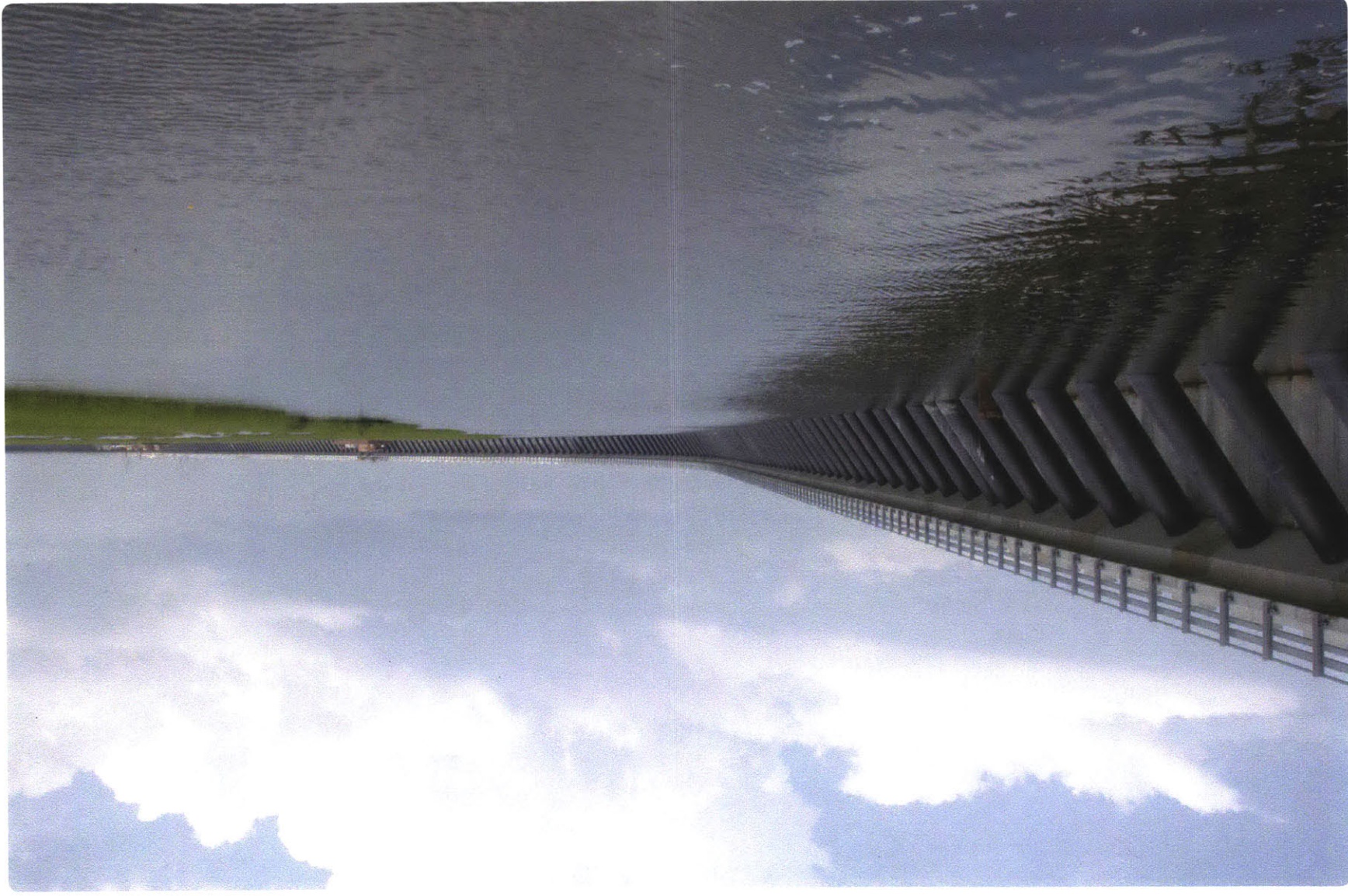






The Lake Borgne Surge Barrier protects the Inner Harbor Navigational Canal from storm surges originating in the gulf. The wall extends 144 feet below the lake bed, and can withstand a 26-foot storm surge. This is considered to be a 400 year event. Completed in 2010 to ensure devastation at the scale of Katrina will not be repeated.









Beneath the Bonnet Carré Spillway, a series of 350 sluice gates capable of bleeding off the Mississippi River into Lake Ponchartrain in order to protect New Orleans which is located 8 miles downstream.



Atop the Bonnet Carre Spillway gates. Since its construction in 1937, the spillway has been used 9 times, protecting New Orleans at the expense of the ecosystems of the spillway itself and Lake Ponchartrain, whose ecosystem is inconsistent with the Mississippi.







Below the lower 9th ward levee, where Brad Pitt and the Make It Right foundation are slowly rebuilding the neighborhood.



Marshes in Barataria National Park: the original, and increasingly scarce, defense against storm surges.





# Bibliography

## General Research

Toimittaneet Marko Home & Mike Taanila. Futuro: Tomorrow's House From Yesterday. Copyright 2002 Desura Oy Ltd, Finland.

Mau, Bruce. Massive Change / Bruce Mau with Jennifer Leonard and the Institute Without Boundaries. London; New York: Phaidon, 2004.

Rem Koolhaas. Keynote lecture on two strands of thinking in Sustainability: Advancement vs. Apocalypse. Ecological Urbanism Conference, Harvard University, 3 April, 2009  
[http://www.oma.eu/index.php?option=com\\_content&task=view&id=132&Itemid=25](http://www.oma.eu/index.php?option=com_content&task=view&id=132&Itemid=25)

John McMorrough. "Design for the Apocalypse," in Thresholds Volume 35 "Difference." MIT SA+P Press. 2009.

Sorry, Out of Gas : architecture's response to the 1973 oil crisis / edited by Giovanna Borasi, Mirko Zardini ; with contributions by Adam Bobbette ... [et al.] ; with an illustrated tale by Harriet Russell. Montréal : Canadian Centre for Architecture ; Montova, Italy : Corraini Edizioni, c2007.

Architecture in times of need : Make It Right rebuilding the New Orleans' Lower Ninth Ward / edited by Kristin Feireiss ; with contributions by Brad Pitt. Munich ; New York : Prestel, c2009.

Anderson, Stanford. Architectural Research Programmes in the work of Le Corbusier

## Maldives

General Statistics: <http://planning.gov.mv/yearbook2010/>

Atlas of the Maldives: 5th Edition. Copyright Atoll Editions 2007. (note: this atlas is specifically noted to be post-tsunami, referring to the 2004 Indian Ocean Tsunami which drastically altered the geography of the Maldives.)

Bradt: Maldives. Fourth Edition 2008. Copyright 2008 Bradt Travel Guides.

## The World Islands Development

Vision Plus Money Plus Historical Circumstance Equals "Cities From Zero" :Unapologetic Expressioins of New-Found Economic, and Therefore Political, Prowess in the 21st Century / edited by Shumon Basar. London: Architectural Association, c2007

The World, Nakheel Promotional Site  
<http://www.theworld.ae/>  
Hulhumale, Housing Development Corporation Promotional Site  
<http://www.hdc.com.mv/>

The Dark Side of Dubai:  
Johann Hari  
<http://www.independent.co.uk/opinion/commentators/johann-hari/the-dark-side-of-dubai-1664368.html>

AMEinfo  
<http://www.ameinfo.com/133896.html>

Van Oord  
[http://www.vanoord.com/gb-en/our\\_activities/project\\_selector/palm\\_jumeirah/index.php](http://www.vanoord.com/gb-en/our_activities/project_selector/palm_jumeirah/index.php)



Shanghai Island  
[http://www.theworld.ae/news\\_shanghai.html](http://www.theworld.ae/news_shanghai.html)

Turkey World  
<http://www.thenational.ae/apps/pbcs.dll/article?AID=/20081228/BUSINESS/732728603/-1/SPORT>

Dubai Debt  
<http://www.marketwatch.com/story/dubai-commits-95-bln-to-dubai-world-2010-03-25>

CIA World Fact Book  
<https://www.cia.gov/library/publications/the-world-factbook/geos/ae.html>

### **Hulhumale Development**

Saudi Aramco (Larry Luxner)  
<http://www.saudiaramcoworld.com/issue/200903/raising.the.maldives.htm>

Hulhumale on NPR  
<http://www.npr.org/templates/story/story.php?storyId=18425626>

DEME  
<http://www.deme.be/Projects/hulhumale.html>

<http://www.un.org/esa/policy/wess/wess2009files/wess09/wess2009.pdf>

### **Coastal Restoration and Defense**

Tsinker, Gregory P. Floating ports :design and construction practices /Gregor P. Tsinker. Houston : Gulf Pub. Co., Book Division, c1986.

Quinn, Alonzo DeF. Design and construction of ports and marine structures[by] Alonzo DeF. Quinn. New York, McGraw-Hill [1972]

Berteaux, Henri O. Coastal and oceanic buoy engineering /Henri O. Berteaux. Woods Hole, MA : The Author, c1991.

Nordstrom, Karl F. Beach and dune restoration /Karl F. Nordstrom. Cambridge, UK ; New York : Cambridge University Press, 2008.

Breakwaters '88 (1988 : Eastbourne, East Sussex, England) Design of breakwaters :proceedings of the conference Breakwaters '88 organized by the Institution of Civil Engineers and held in Eastbourne on 4-6 May 1988. Telford, 1988.

Breakwaters, coastal structures and coastlines :proceedings of the international conference organized by the Institution of Civil Engineers and held in London, UK on 26-28 September 2001 /edited by N.W.H. Allsop. London : T. Telford, 2002.

Leefbaar laagland. English. Man-made lowlands :history of water management and land reclamation in the Netherlands /G.P. van de Ven, editor. [Utrecht] : Matrijs, 2004.

International Conference on Coastal Engineering (30th : 2006 : San Diego, Calif.) Coastal engineering 2006 :proceedings of the 30th international conference : San Diego, California, USA, 3-8 September 2006 /editor, Jane McKee Smith. Hackensack, N.J. ; London : World Scientific, c2007.

Sheppard, Charles (Charles R. C.) The biology of coral reefs /Charles R.C. Sheppard, Simon K. Davy, and Graham M. Pilling. Oxford ; New York : Oxford University Press, 2009.

Shanghai Island  
[http://www.theworld.ae/news\\_shanghai.html](http://www.theworld.ae/news_shanghai.html)

Turkey World  
<http://www.thenational.ae/apps/pbcs.dll/article?AID=/20081228/BUSINESS/732728603/-1/SPORT>

Dubai Debt  
<http://www.marketwatch.com/story/dubai-commits-95-bln-to-dubai-world-2010-03-25>

CIA World Fact Book  
<https://www.cia.gov/library/publications/the-world-factbook/geos/ae.html>

### **Hulhumale Development**

Saudi Aramco (Larry Luxner)  
<http://www.saudiaramcoworld.com/issue/200903/raising.the.maldives.htm>

Hulhumale on NPR  
<http://www.npr.org/templates/story/story.php?storyId=18425626>

DEME  
<http://www.deme.be/Projects/hulhumale.html>

<http://www.un.org/esa/policy/wess/wess2009files/wess09/wess2009.pdf>

### **Coastal Restoration and Defense**

Tsinker, Gregory P. Floating ports :design and construction practices /Gregor P. Tsinker. Houston : Gulf Pub. Co., Book Division, c1986.

Quinn, Alonzo DeF. Design and construction of ports and marine structures[by] Alonzo DeF. Quinn. New York, McGraw-Hill [1972]

Berteaux, Henri O. Coastal and oceanic buoy engineering /Henri O. Berteaux. Woods Hole, MA : The Author, c1991.

Nordstrom, Karl F. Beach and dune restoration /Karl F. Nordstrom. Cambridge, UK ; New York : Cambridge University Press, 2008.

Breakwaters '88 (1988 : Eastbourne, East Sussex, England) Design of breakwaters :proceedings of the conference Breakwaters '88 organized by the Institution of Civil Engineers and held in Eastbourne on 4-6 May 1988. Telford, 1988.

Breakwaters, coastal structures and coastlines :proceedings of the international conference organized by the Institution of Civil Engineers and held in London, UK on 26-28 September 2001 /edited by N.W.H. Allsop. London : T. Telford, 2002.

Leefbaar laagland. English. Man-made lowlands :history of water management and land reclamation in the Netherlands /G.P. van de Ven, editor. [Utrecht] : Matrijs, 2004.

International Conference on Coastal Engineering (30th : 2006 : San Diego, Calif.) Coastal engineering 2006 :proceedings of the 30th international conference : San Diego, California, USA, 3-8 September 2006 /editor, Jane McKee Smith. Hackensack, N.J. ; London : World Scientific, c2007.

Sheppard, Charles (Charles R. C.) The biology of coral reefs /Charles R.C. Sheppard, Simon K. Davy, and Graham M. Pilling. Oxford ; New York : Oxford University Press, 2009.



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[www.bucksleeper.com](http://www.bucksleeper.com)

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